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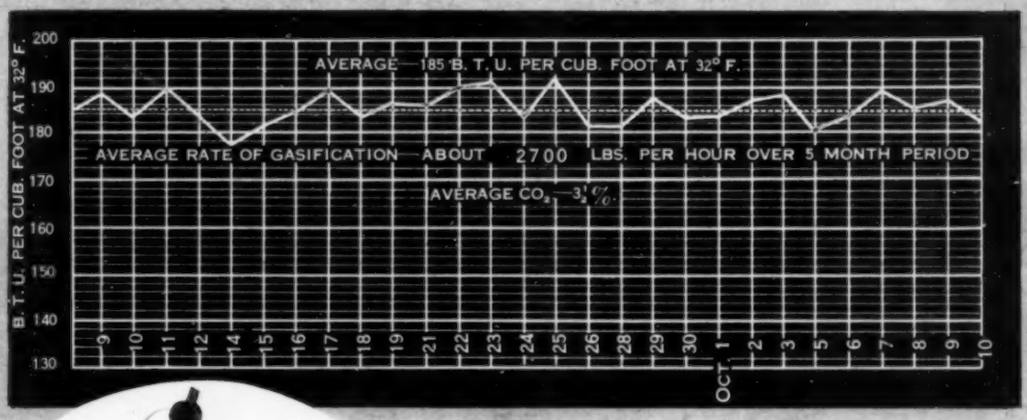
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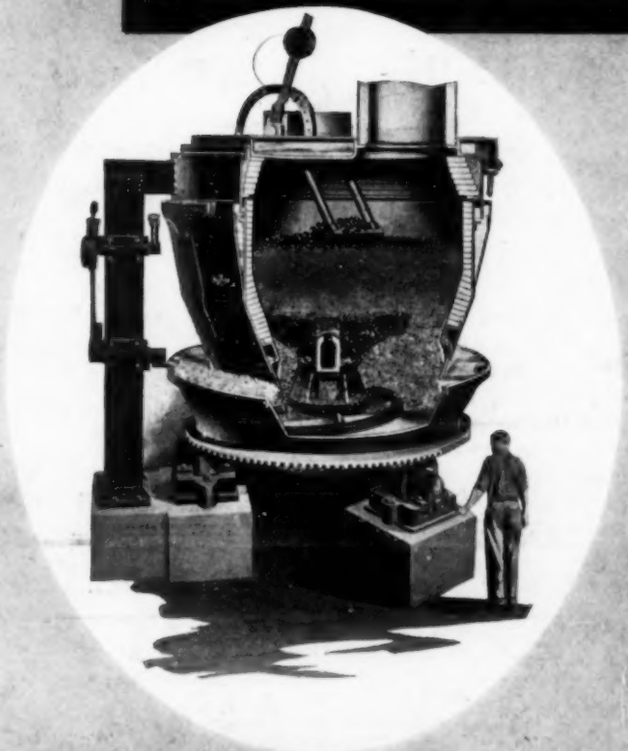

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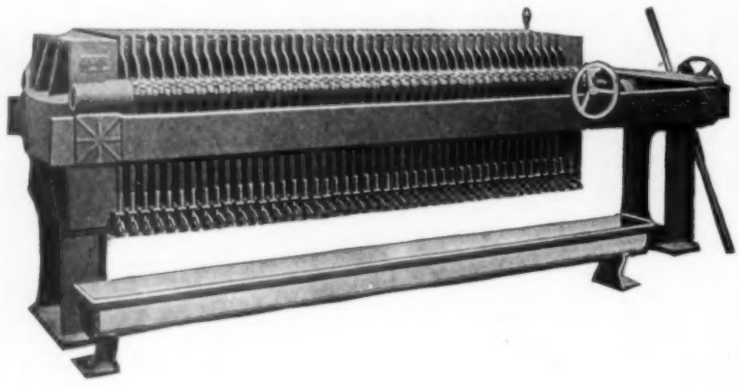

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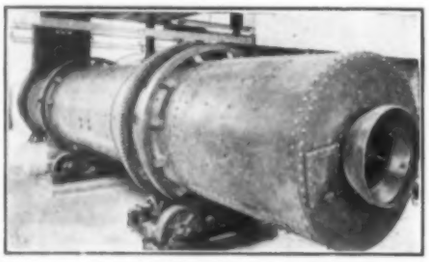

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The Threatened Railroad Strike

SOBER opinion in well-informed circles is to the effect that the railroad strike will not occur. We make no prophecy, but merely record the belief of those who have knowledge of facts on which they base their opinion. But even the layman without inside knowledge finds it difficult to imagine that the great railroad labor leaders can be so heedless of public opinion or blind to the consequences of their folly as to permit the threatened strike to be consummated. The issue is clear cut and thoroughly understood by the people and they will have none of it. They will show no sympathy for men who, at a time when industry is characterized by unemployment, would force millions of men into the ranks of the idle and paralyze the transportation system of a great nation. Fortunately it looks as though the Government is not to be cowed with threats, nor coerced or intimidated into a surrender. The threatened strike is plainly a revolt against the carefully considered decision of a Government agency. It is not the outgrowth of a controversy between employees and employers. It is a flat refusal to accept a reduction of wage ordered by the same board which a year ago granted an increase in wage. It is a plain refusal to play the game fairly and squarely. We have yet to see the first expression of public sentiment favorable to this attitude on the part of the unions, and while there may be some doubt as to whether the strike will eventuate or not, there is not the slightest question as to the outcome in case it occurs. Unionism will have dealt itself a blow from which it will not soon recover. The strike has been conceived in selfishness on the part of a small group of citizens and its success would be a crime against a nation that has been patient and long suffering with railroad workers.

Nobody To Blame

"NOBODY to blame." This, briefly, is the remarkable verdict of the Coroner's jury published after investigating the disaster to the ZR-2, which fell a blazing mass of junk into the River Humber a few weeks ago, burning out all but five of the fifty gallant lives aboard. "Nobody to blame." This is to say, the holocaust was either an accident not to be foreseen and guarded against, or an act of GOD. Surely such a verdict is the epitome of human stupidity or blasphemy!

In appraising this disaster engineers should remember several things: First, that the facts regarding this and similar occurrences are buried in governmental archives or known by uncommunicative officers. Second, that the first rigid balloon was built only fifteen years ago, and since then very few have been made alike; consequently accurate information about operating loads and stresses of necessity is lacking. Third, that the metallic portions of such machines are made of new alloys, about whose manufacture and properties much yet remains to be known.

Our consideration should therefore be focused on two phases of the subject: First, Was the design adequate? Second, Were the materials trustworthy? Grave doubts exist on both these questions; an answer of "No" in either case would be fatal. Put bluntly, they were pitting unknown metal against uncertain loads. Is this an "act of GOD"?

As is perhaps common knowledge, the main skeleton of a modern airship consists of a series of giant bicycle wheels, wired to the center, and set at 15- to 20-ft. intervals. Longitudinal members hold them apart, and each rectangular side panel is wired on its diagonals. Inclosed are the gas bags, to the end are fixed the rudders and below are hung engines and cabins.

Now, from a design standpoint, a main structure can be so arranged as to be determinate to a definite assumed loading—i.e., all the stresses can be figured in the various properly disposed members when forces in definite amount are applied at definite points and in definite directions. Such forces would of course be chosen to represent what is thought to be the most severe operating conditions. Then all the parts can be designed to be safe against these stresses. Of course, one may assume a number of other loadings for other conditions of operation and figure the resulting stresses. Consequently a great many possible loadings would be analyzed in the design, and the final structure would provide for the heaviest combination.

Those who have wrestled with loads and deformations of continuous bridges or gas holders will realize that the problem of airship design is far from simple. The reactions to shifting loads depend upon the elasticity of the structure. When an airship is flying, various combinations of loads are present whether or not they have been so assumed in the preliminary calculations, and they shift themselves in amount and direction automatically with great rapidity, without asking leave of the designer. As our British contemporary *The Engineer* observes, even on the simplest assumptions "airship loadings are diabolically complex, and there is an amazing difference in principal shearing stresses between the inflated and empty condition." Imagine, therefore, what would happen in the members of a huge, fragile craft when buffeted by cyclonic gusts, or if a gas bag should burst when turning at high speed, thereby developing tremendous loads due to inertia. Still, "No one is to blame"!

The Engineer notes as matters of history that it is remarkable that airships have been consistently destroyed; approximately 100 have been constructed in the last fifteen years, the latest costing $2,500,000, yet there are not a dozen fit to fly today. Forty of them were shot down during the war. While as naval scouts they have gathered valuable information, they are practically worthless in action when opposed by airplanes.

Twenty-six built between 1905 and 1914 came to grief, usually not while flying, but by storm or fire, occurrences which were also frequent during the war. Ten years ago British Naval Airship No. 1 broke amidships with the greatest ease while being taken out of the erecting shed. Yet now "Nobody is to blame"!

Enough for the features of pure design. We do not wish to accuse the designers of failing to act according to their best lights; but it will be evident from the history of airships that many elements of uncertainty surpass the assumptions made by the constructors. It is easily possible that a perfectly built structure would have failed because of excessive and unexpected forces. But what of the materials of construction?

In airships the members are built of 1¼ x 1¼ x ⅛-in. duralumin angles. Duralumin is a peculiar alloy of aluminum and copper, with a little magnesium and manganese. It is "hardened" aluminum. It was discovered by WILM less than twenty years ago, and was in production in Germany before a list of its physical properties was published. That was in 1911, and for several years it was regarded as a metallurgical mystery—its behavior contradicted all expectations. It has the peculiar property of aging: after a proper quenching it increases in hardness and strength at room temperature, rapidly during the first few hours, but progressing at a slower rate for days. Such metal appeared to shock conservative metallurgists, who unconsciously judge the soundness and quality in metal by the degree of permanence of its properties.

In the last four or five years much scientific work has been done on such aluminum alloys, and much of it is published, so that the aging action is no longer so surprisingly bizarre. In fact, its various changes, with changes in composition and heat-treatment, have been co-ordinated with like facts known for many other common alloys, and duralumin has found its place in metallurgical theory without disrupting any of our fundamental conceptions. In fact the broad theory is being used daily to predict the expected action of this new alloy under untried circumstances.

So now it is known to the testing engineer that light aluminum alloys when rolled into thin sections "tear" very easily, making it essential that the metal's outer surface and inner texture be absolutely free of even microscopic notches, where concentrated stresses build up and all manner of evil results. Many American foundrymen have been driven near distraction when trying to make thin aluminum castings which didn't look like old-fashioned cast steel—an accumulation of bubbles held together by films of metal. They can appreciate the skill and sound technique required to cast thoroughly sound ingots, free from surface defects, and then roll these ingots into small shapes of really smooth surface and undamaged edges.

When we entered the war, our Government received and handed over to certain producing companies all that was then known in England and France regarding the manufacture and properties of these airship alloys; yet we are able to state advisedly that constant and intensive investigations directed by American metallurgists, second to none in the world, have only now enabled the production of duralumin of quality without a prohibitive number of rejections and the development of puzzling defects shortly after fabricating. A thoroughly dependable metal can be produced when its vagaries have been studied and mastered, but is it safe to assume that the metal entering into the construction of the ZR-2, cast and rolled about three years ago, was any better or more dependable than our own technicians would have then produced?

Yet "Nobody was to blame"! Such a verdict is merely stupid. It must have been the refuge of a group of men, ignorant of engineering, and uninformed. But there must have been men present at the inquest who know more about the points at issue than the writer of these lines. Why did they sit silent? Perhaps the new legal philosophy of America has already entered their hearts: "I refuse to answer, by advice of counsel, on the ground that it might tend to incriminate me."

Signs of Promise

TWO events of the past week are calculated to hearten those who sit in the watch towers of chemistry and look for signs of promise. One was the dedication of the new chemical laboratory at Cornell University and the other the inauguration of a new course in chemical engineering in Sheffield Scientific School of Yale University. Each represents an influence set in motion, whose ultimate effects on science and industry cannot be foretold.

Unusual importance attaches to the new laboratory at Cornell because its donor is a New York banker, GEORGE F. BAKER, chairman of the board of directors of the First National Bank of that city. His identity was not made known until the building was dedicated and he himself laid the cornerstone with a silver trowel. Mr. BAKER has taken advantage of an unusual opportunity to contribute to the welfare of his generation, and not of his generation alone, but of his country for generations to come. No one can estimate the beneficence of such a gift to a science the application of which is daily proving itself to be the greatest single factor in our national welfare, whether for peace or war. His example may well be emulated by others with philanthropic ambitions; nor need the exhortation be limited to bankers alone. Beneficiaries of chemistry there are who can pay no better tribute to the industry in which they made their success than to endow instruction in chemistry. The example of Mr. EASTMAN and his gifts to "Tech" are still fresh in the memory.

Of chemical engineering at Yale much can be expected when the course becomes well established and facilities in the way of buildings, equipment and endowment funds are more generously provided. But what the institution may now lack in physical equipment it possesses in personnel and policies. Firm in their belief that instruction in chemical engineering should be directed mainly to the fundamentals of science and mathematics, with intelligent perception of their industrial applications, the faculty has adopted a policy that will do much to offset any lack in buildings or equipment. It is true that the course inaugurated is only of four years duration, but when it is remembered that until last year "Sheff" had only three-year courses in engineering, it will be seen that chemical engineering starts on advanced ground. Nevertheless we express the hope that the course may yet be extended to five or six years, or lacking this, that the students may be prevailed upon to return for post-graduate courses. We congratulate the institution on the inauguration of this department and express the hope that progress will always be evident in the development of the curriculum.

Development Of Transportation

WHAT is to be the greatest industrial work in the United States in the next decade? Prophecy is always hazardous at best, but a general survey seems to suggest that the greatest work will be the development, in the broad sense, of transportation.

There are various ways of guessing what men will do. One is to consider what they have opportunity to do, another what they need to do. Taking the latter tack, some data can readily be collected. The fact has been emphasized of late that normally there are about 2,000,000 persons engaged and drawing pay, if not actually at work during all of the Adamson eight-hour period, in rail transportation. That seems like a very large number out of a total of about 45,000,000 persons, including clergymen, public servants, teachers, office boys and others, engaged in gainful occupations according to Census Bureau showings, particularly when it is considered that there is a great deal of transportation besides rail transportation. It looks as if some improvement could be effected, releasing men for other work.

Then we have had a good bit of information about the freight cost of certain commodities, not many, but some, being more than half the total cost. That looks bad, although sometimes there are extenuating circumstances. Remembering that we are considering transportation in the broad sense, we have had many illustrations of the great difference between the value of food on the farm and on the table. Transportation and distribution are linked together—that is, they ought to be.

We have had preaching for many years about the great value of our natural waterways and of artificial waterways, with much citation of facts to show the economy. Apparently we need to utilize these advantages. One may ask why, if this needs to be done now, it did not need to be done just as much years ago. The fact is that a great change has occurred. Railroading is less than a century old. The greatest mileage of railroad constructed in a year was in 1887, only a third of a century ago. Once built, a railroad needed traffic. There was a very heavy overhead. It is only in quite recent years that the major portion of the railroad mileage has had to work at anything like capacity. There was no economic advantage in relieving a railroad of traffic it needed and could well handle, any more than there would be economic advantage in maintaining two parallel railroads when one could perform all the service desired.

Considering transportation in the broader sense, we have the obvious need of transporting power. We transport much coal at great expense, and use it inefficiently in small power units, when we need to consume the coal economically in large units at the mine and transport the power over a little copper wire, easily maintained.

From the other viewpoint that may be taken in attempting to guess what men will do in the next decade, that of what men have opportunity to do, we see the opportunity of operating railroads more economically, by better administration of freight cars so that they shall carry goods more miles per day per car, by electrification, by block signaling and by other improvements. We see the motor truck developed beyond a parity with the roads on which it should travel, so we have opportunity to build more and better roads. We see waterways ready to be used, requiring only the building of boats and the installation of terminals. We see canal-building machinery and appliances that will produce given results with much less expenditure of man power than a quarter of a century ago.

We shall always be a restless nation, requiring much transportation of ourselves and our goods, so the market for transportation will always be a broad one. It is the very fact that transportation has been so urgently demanded in rapidly increasing quantities that transportation is not as efficient as it might be. If a commodity will be bought only if the price is low, efficiency makes the price low, but if it will sell anyhow, efficiency may be neglected. That has been the case with transportation.

Russian Chemists Sorely Need Help

SINCE printing an editorial on "Russian Chemists and Organic Chemistry" in our issue for Sept. 14, 1921, several letters have been received from their exiled brothers giving fragmentary information, often contradictory on account of incorrect rumors or tardy post. It appears that Dr. C. N. IPATIEFF served with the Russian Army during the great war, attaining the rank of General. Such duties of course prevented any scientific studies, and it has doubtless been difficult to continue them of recent years, lacking the necessary reagents and apparatus, which must be missing in a country whose very hospitals are stripped of bare necessities. A letter from London contains the sad news of his sickness and death, but another report through German channels speaks of him as still being well. Likewise, two reports have been received concerning Professor OSTROMISLENSKY, one saying that he is alive, but a clipping from a German paper states that he was killed at Moscow. We have also been given the shocking news that Professors KONOVALOV and ZELINSKY died of starvation and exposure as late as last year. Whether the Soviet rulers realize it or not, the loss of such human material is a serious handicap in the advancement of the "proletariat."

The proposal to send out a search party to find some of the survivors was not a flippant phrase, but a serious recommendation. Since HOOVER'S relief forces have penetrated Russia, it has probably dawned upon the official mind that every philanthropic effort is not propaganda or an attempted economic penetration of Russia. Could not the American Chemical Society charge a committee with the duty of communicating with prominent members of the once-influential Russian Chemical Society, with the idea of discovering their necessities and formulating some plan of relief? It may be that many other brilliant chemists are approaching the fate of KONOVALOV and ZELINSKY.

Food supplies can now be forwarded to designated individuals through HOOVER'S relief. Or it may be found that the greatest lack is equipment and scientific literature; in fact GORKY has been reported as saying that the greatest difficulty now existing for successful work in the arts and sciences is the absolute intellectual isolation of Russia. Public prints now assure us that the economic blockade has been lifted by all outside governments; international communications, though bad, should now allow the passage of necessary shipments, which doubtless would be forthcoming by generous donation if the facts were known.

Who will lend a helping hand?

Readers' Views and Comments

Sound Ingots and Rails as a Matter of Course

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have recently reverted to the valuable articles by Dr. G. K. Burgess, of the Bureau of Standards, Washington, D. C., and the editorial comment relating thereto appearing in the issues of CHEMICAL & METALLURGICAL ENGINEERING for Nov. 10, 17 and 24, 1920. These articles refer to the hundred tons of ingots the writer's firm sent over to America in 1913, made by what is termed the "Hadfield sound steel method." As Dr. Burgess' report showed, these rails were found to be of excellent quality and particularly free from defects.

There is no doubt that the system could be satisfactorily applied to the production of rails on a large scale. It may be added that there have been attempts to follow or copy my system, but unfortunately those doing so have generally left out some particular portion of the *modus operandi* recommended and practiced by my firm, the result being that the system has not had a full and proper chance of being investigated and tested on a large scale.

In view of the difficulties met with in the present type of rails used in roadbed construction, it seems regrettable that the important advantages of manufacture of this system, to which reference is now made, have not been fully and properly tested.

Notwithstanding the efforts adopted by the railroad company to inspect closely the "permanent way," as we call it over here (in your country "roadbed"), which of course includes the rails, serious breakages of rails are constantly occurring. Besides, the heavy expense required to watch over the roadbed closely enough to prevent accidents is a matter of serious moment. Much of this inspection of steel rails would be unnecessary if steel sound and free from defects, as is quite possible, were used.

The increasing severity of the stresses and abrasion upon steel rails is brought home to the mind when one reads about the American coal train of such extraordinary length pulled by a Mallet engine and representing a string of no less than one hundred 120-ton cars of coal, which ran over the Virginian R.R. on Wednesday, May 25, from Princeton, W. Va., to Sewall's Point. The total trainload aggregated no less than 16,000 gross tons, and the length would probably be not far short of one mile.

In view of the fact that many rails are practically of tool steel temper—that is, as hard as is used for drills, chisels and other similar products—it will be understood that hard steel, which usually means brittle steel, is being severely stressed. In my opinion unless properly made and treated these will be liable to failure under these heavy loads and severe conditions.

At our recent conference at the Institution of Civil Engineers in London, several interesting papers on railroad matters were read, and discussion took place regarding rail failures. It was clearly proved that the microscopic cracks, from which most of these troubles originate, occur from want of care in the production of

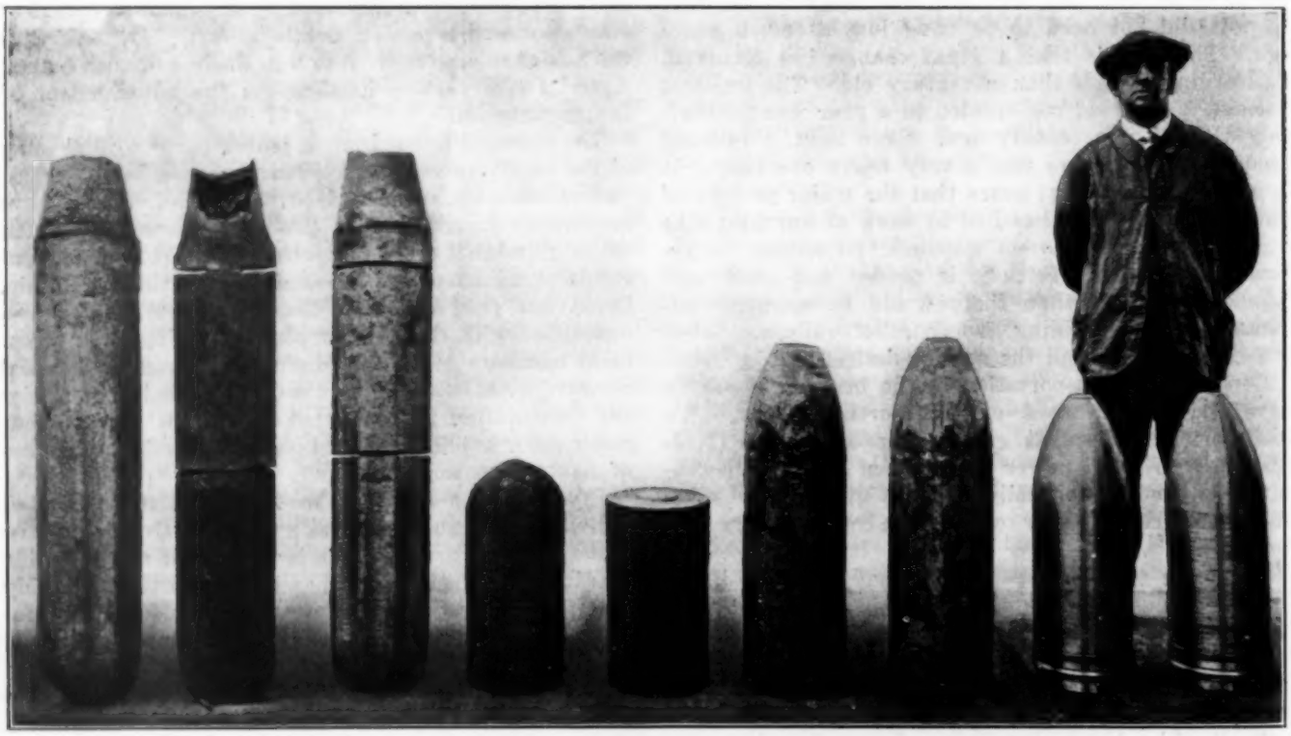


FIG. 1. HADFIELD-JACK METHOD (PATENTED) APPLIED TO SHELL MANUFACTURE

From left to right is shown the special billet as cast; one of them sectioned longitudinally; a billet parted ready for breaking; the two portions ready for the press; after pressing, and then two finished shells. It will be noticed that the forged blanks are somewhat longer than when finished, to furnish material for physical tests.

the original steel in the ingots from which the rails are rolled.

While it is not desirable to exaggerate the situation as some may have done, an improvement is certainly demanded. The following may seem a bold statement to make, but it can readily be proved to be true—namely, that given suitable plant and properly trained superintendents, it is possible to insure that only sound ingots would be passed to the rolling mill, also that every ton of ingots could be produced absolutely sound and from which nothing but sound rails would result. To put the matter in another way, it could be made quite practicable to accept a contract for 10,000 tons or, for the matter of that, hundreds of thousands of tons, of ingots, all of which would be sound and from which all the rails produced would be sound and free from defects.

The great point I wish to make is that under this system not a single ingot could get through which was not inherently sound and that this could be known before the ingot went into the rolling mill itself, whereas now the ingots vary in a very wide and dangerous degree in this respect and it is not known whether they are sound or not. Even if through any untoward accident of carelessness in the heats, some ingots were produced which would not meet the requirements, my point is that these would be known and detected before they reached the rolling mill. It will therefore be seen that the statement that if, say, a million tons of ingots was produced, every one of them would be sound and free from the troubles so frequently met at the present time, is, as shown in my various papers on this special subject, based not on imagination but on statements of fact and actual practice already carried out.

To deal with this rail problem adequately it is necessary to begin by inspection of the ingots—that is, this would not, as at present, be left until the rails themselves were produced, in most of which it is not possible to detect the flaws and imperfections, though they are there, as these cannot be seen.

The reply may be made, "Yes, but at what cost can this be done?" The answer to this is that with a properly systematized plant and operators, the extra cost involved would be comparatively slight. Besides, and in the end, with better methods such extra expense pays, as it is always economical to make and use good products. If some enterprising railroad would say, "We will try five or ten thousand tons of rails made in this manner," then the reply would be, "It can have sound rails, though naturally for small lots there would be, until manufacture was systematized on a large scale, some extra charge necessarily involved."

As further evidence of sound material, if such be needed, the attached Fig. 1 may be of interest to your readers. It shows the application of the Hadfield system to the casting of high explosive shell, of which my firm made hundreds of thousands during the war. It will be noticed that the blank in this particular photograph was not for one shell only, but for producing *two* in one blank, which greatly reduced the cost and time. Excellent results were obtained in making hundreds of thousands of these double blanks; notwithstanding the rapid production, there was practically an entire absence of waster shell from any cause, whether unsoundness, machining quality, mechanical properties or firing tests. As I claim in the case of ingots for rail making, an unsound blank is readily detected before any forging, pressing or other work is put on it.

Other photographs could be reproduced to show the application of the Hadfield system to 12-in., 15-in. and even larger shell cast in single blanks. Similar success to that mentioned above as regards 9.2-in. attended the production of these larger calibers.

In all these cases, especially as regards the larger shell, where the machining surface was so considerable, I do not remember my firm having a single rejection for unsoundness. In these larger calibers it was possible, as with the smaller ones, to determine quickly whether the blanks were in proper sound condition before putting a single minute of work on to them.

I claim that rails can be made in the same way just as sound as high explosive shell. Such rails would be quite sound, also free from segregation and other defects.

ROBERT S. HADFIELD.
Hadfield, Ltd.,
Sheffield, England.

Credulochemistry

To the Editor of Chemical & Metallurgical Engineering

SIR:—Apropos of your recent editorial on "Credulochemistry," I would call your attention to the occurrence of this new science even in such an orthodox place as the Chemical Exposition. The following extracts from circulars which I received at a booth there illustrate some of the modern views of the adherents of this new science:

"There are, practically speaking, but two kinds of floor hardeners: One made of magnesium silicate, the other sodium silicate. Magnesium silicate is obtained from mica, hence cannot be any harder than mica, its base. While it acts very readily on the free lime in the cement, its hardening qualities are limited to the hardness of mica.

"Sodium silicate, which is used in —— Floor Hardener with various other chemicals and gums, is spar. The purest form of spar known is red granite, which in turn is four times as hard as mica. In acting on the free lime in the concrete sodium silicate renders it four times as hard as when magnesium silicate is used.

"The hydrofluorine formed by the chemicals used in —— Floor Hardener reacts powerfully on concrete and makes sand soluble and forms it into a mass as hard as flint."

The same "chemical" (?) company has made important discoveries in the organic branch of Credulochemistry, one of the most interesting of them being a linseed oil substitute, described in another circular, from which I quote a few sentences:

"The most general characteristic of —— Oil is its property of depositing a thin but strong waterproof and porous-proof film; resisting weak acids, strong acids and full-strength acids, even if in solution form. It is high-resisting, non-explosive and less harmful (?) than linseed oil. It is a chemical and mineral oil, called a chemical and mineral oil because of its chemical properties [*sic!*] and purely mineral bases, and is superior in every way to linseed oil or any other paint oil made."

While it may be too much to expect the management of the Chemical Exposition to censor all of the printed matter distributed by exhibitors, yet there would not be much difficulty in general in picking out those who, from the nature of their business, would be most likely to perpetrate such atrocities in the name of chemistry, and keeping a watchful eye on their activities.

FRANCIS C. FRARY.
Oakmont, Pa.

Edward R. Weidlein, New Director of Mellon Institute

ANNOUNCEMENT has been made by the board of trustees of the University of Pittsburgh of the appointment of Edward Ray Weidlein as director of the Mellon Institute of Industrial Research. Mr. Weidlein has been acting director since the recent resignation of Dr. Raymond Foss Bacon, and prior to that time, since 1916, he served as associate director. Dr. Bacon, who left to engage in consulting chemical practice in New York, became director at the time of the death, in 1914, of Dr. Robert Kennedy Duncan, the first director of Mellon Institute and formulator of the Institute's successful system of establishing practical co-operation between science and the chemical industry.

Mr. Weidlein was a student of Dr. Duncan and later became an Industrial Fellow of the Mellon Institute. He has been associated intimately with the industrial fellowship system since 1909, and since 1916 has been a member of the administrative staff of the Mellon Institute. He has had a rich experience in the supervision of industrial research and enjoys a high national reputation as a specialist in the systematic investigation of the problems of chemical and physical technology. In addition, he brings to his new post of responsibility a boundless enthusiasm which has resulted from his studied devotion to the ideals of the industrial fellowship system of the Institute and from his naturally vigorous optimism.

EDWARD RAY WEIDLEIN

Commenting on Mr. Weidlein's appointment, an officer of the University of Pittsburgh said: "His broadly sympathetic and luminous mind moves on a plane so near to that of Dr. Duncan, the founder of the Mellon Institute's system of research, that he knows this grand scheme of thought as it was developed; he brings to this important position and to the interpretation and diffusion of the Institute's industrial fellowship system such a happy combination of qualities as one very rarely meets with."

Edward Ray Weidlein was born at Augusta, Kan., on July 14, 1887. He was graduated at the University of Kansas, Lawrence, Kan., with the degree of Bachelor of Arts in the year of 1909; in 1910 he received the degree of Master of Arts. From Dec. 1, 1909, to March 1, 1910, he was engaged in a study of camphor, under the direction of the late Dr. Robert Kennedy Duncan. From March 1, 1910, to Oct. 1, 1912, he carried out a comprehensive study of the ductless glands, during the course of which he investigated epinephrin from the whale. From Oct. 1, 1912, to Oct. 1, 1916, Mr. Weidlein was a Senior Fellow in the Mellon Institute of Industrial Research, having supervisory charge of all of the Institute's investigations on the metallurgy and hydrometallurgy of copper and having direction of the experimental plant at Thompson, Nev. In connection with this investigatory work Mr. Weidlein developed a process for the use of sulphur dioxide in hydrometallurgy which has aroused wide interest because of its economic importance.

On July 10, 1916, Mr. Weidlein came to the Mellon Institute at Pittsburgh as assistant director; on Oct. 1, 1916, he was appointed associate director and he became acting director in 1918, during the leave of absence of Colonel Raymond F. Bacon as Chief of the Technical Division of the Chemical Warfare Service, A.E.F. On March 12, 1918, Mr. Weidlein was appointed chemical expert for the War Industries Board. His activities on this board received the highest official commendation.

The forty-eight Industrial Fellowships or scientific investigations of important problems of manufacturing in operation at the Mellon Institute cover a wide range of problems in chemical and mechanical technology. Mr. Weidlein maintains a constantly active supervision over these researches. He has had this intimate relationship with the industrial fellowship system since its formulation by Dr. Duncan in 1917.

The following are some of the important journal contributions of Mr. Weidlein:

"Jamaica Camphor" (with H. W. Emerson), *Journal of Industrial and Engineering Chemistry*, vol. 4, pp. 33 to 36.

"Epinephrin From the Whale," *Journal of Industrial and Engineering Chemistry*, vol. 4, pp. 636 to 645.

"Recent Developments in Connection With the Use of Sulfur Dioxide in Hydrometallurgy," *Journal of Industrial and Engineering Chemistry*, vol. 9, pp. 1057 to 1058.

"Conservation of Heat in Power and Heating Systems," CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, pp. 295 to 300.

"Science and Industry," *Textile World Journal*, vol. 53, No. 44, pp. 186 to 191.

"The Industrial Fellowships of the Mellon Institute," *Science*, N. S., vol. 47, No. 1219.

Mr. Weidlein's inventions in the field of the hydrometallurgy of copper are claimed in U. S. Patents 1,089,096 and 1,201,899; in Canadian Patent 173,040, of Nov. 7, 1916, and in British Patent 10,500, of April 28, 1914.

Mixed Orientation Developed in Crystals of Ductile Metals by Plastic Deformation

The Hull Method of X-Ray Crystal Analysis Answers This Contentious Question in a Positive Manner—Cold-Work Produces Change in Orientation Within the Original Grains

BY EDGAR C. BAIN AND ZAY JEFFRIES

IN EXPLAINING the mechanism of slip by which plastic deformation of a metal proceeds, Tammann[1] offers only two modes of motion, translation and twinning. Lehman[2] has pointed out that movement is possible by fluid flow in crystals, but metallographists and physicists are in general agreement that plastic deformation in metals results from some form of block movement of crystal fragments along slip planes. Since the mechanical twin bears certain fixed relations to the parent crystal, it cannot be said to give any evidence of general rotation or change in orientation. In terms of our modern conception of atomic structure, these earlier assumptions mean that in general parallel atomic planes of atoms during deformation remain constantly parallel to the positions in which they were in the original grain. As regards the geometry of even quite drastic deformation this is theoretically quite possible. Howe[3] aptly

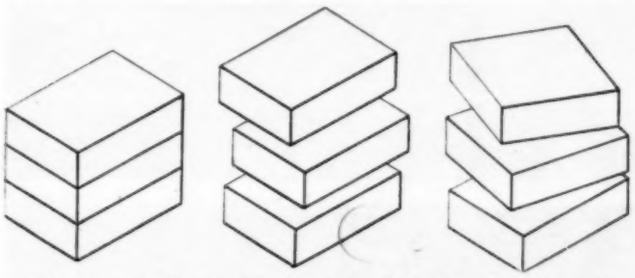


FIG. 1. DIAGRAM OF SLIP IN CRYSTAL BLOCKS BY TRANSLATION AND ROTATION

likens this sort of plastic deformation to the motion of the compass needle in the skater's pocket, which is vectorial or translatory, even though the skater's gyrations are rotary. Fig. 1 diagrams a few crystal blocks slipped by translation and by rotation.

Matthewson and Phillips[4] criticise this view of Tammann and fail to understand a rearrangement and reorganization of a deformed grain after annealing unless its fragments, enveloped by amorphous layers, have been differently oriented. They maintain that if Tammann's opinion were correct, then annealing would simply stabilize the grain in its altered position. Carpenter and Elam[5] are inclined to hold to the view that no new orientations are produced in a grain during deformation. To quote: "There is no evidence known to the authors that after deformation the orientation of a crystal differs in any way throughout its extent." They base their conclusion upon the regularity of etching pits even after severe deformation. Howe[6] to a great extent seems to corroborate this impression. "The regularity of the etching pits in each grain even after extreme plastic deformation and the sharp change in their direction from grain to grain are very cogent evidence of the retention of substantial uniformity of orientation during deformation."

One of the present authors,[7] however, while granting the general truth of the regularity of etching pits in cold-worked metals, believes that the methods of determination of the regularity of direction in etching pits are not sufficiently accurate to warrant more than a qualified statement of the tendency and points out that the pits are usually examined in sections which are most likely to show minimum alteration of orientation. Yet cold-worked metals recrystallize on proper annealing, and "no explanation of the recrystallization of cold deformed metals on annealing has been forthcoming which did not assume a change in orientation within the initial grains due to the deformation."

[1]Lehrbuch der Metallographie, Gustav Tammann, p. 56.
[2]*Zeit. für Met.*, vol. 13, Nos. 3, 4 and 5.
[3]The Metallography of Steel and Cast Iron, Howe, p. 295.
[4]*Trans.*, Am. Inst. of Min. Eng., 1916, p. 1.
[5]"Crystal Growth and Recrystallization in Metals," *J. Inst. Met.*, No. 2, 1920, p. 112. CHEM & MET. ENG., vol. 24, p. 224 (Jan. 2, 1921).
[6]*Trans.*, Am. Inst. Min. Eng., 1917, p. 2117.
[7]Jeffries, *Trans.*, Am. Inst. Min. Eng., 1917, p. 2071.

FIG. 2. VERTICAL SECTION OF TYPICAL INGOT FROM WHICH THE COARSE-GRAINED SPECIMENS WERE CUT. ACTUAL SIZE

To sum up then, there is a disagreement as to whether or not deformation is accompanied by rotation and production of new orientations.

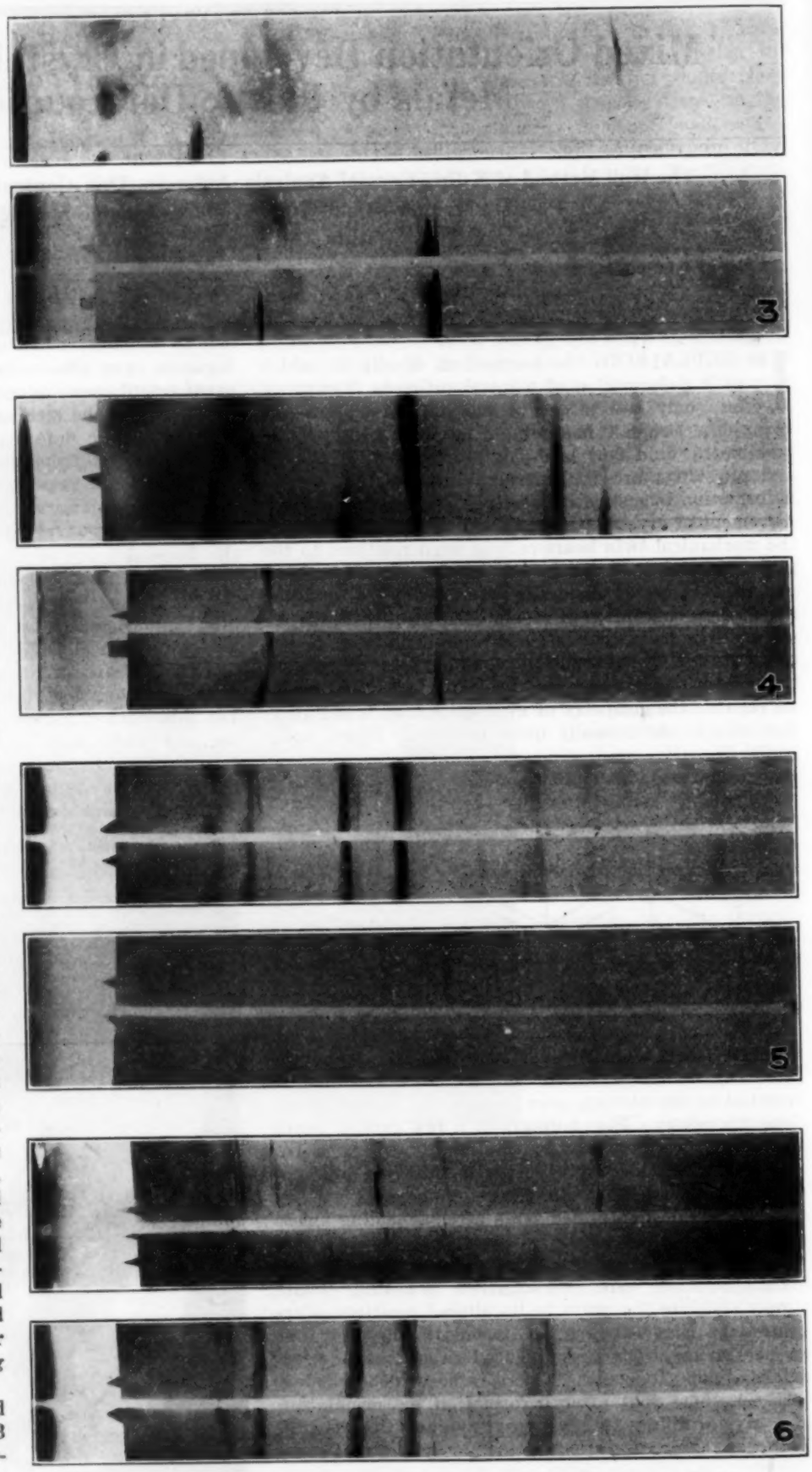
The authors have employed a new method of examination which offers a complete answer to the question of rotation during deformation. *If a very coarse grained specimen of metal containing only a few grains develops a complete assortment of orientations upon deformation by rolling alone, it would be positive proof of rotation of crystal fragments during deformation. This the authors have demonstrated conclusively.*

It was pointed out by Bain[1] that the Hull pattern produced by the X-ray spectrometer was quite distinctive for different orders of grain size. A very coarse-grained specimen may show only one or two broad dashes on the film—indeed conceivably none at all—while with refinement of grain size the dashes decrease in size and increase in number. With very fine grain size the general pattern is produced on the film with smooth bands having even gradations on the edges.

For these experiments very coarse grained ingots of copper and aluminum were used. Fig. 2 shows a typical vertical section through the cast metal. This grain structure was developed by slow cooling. Specimens about $\frac{3}{8}$ x $\frac{3}{8}$ x $1\frac{1}{2}$ in. were cut from the large ingots by a milling cutter. Great care was used to prevent deep strains. The specimens were polished and etched twice to remove superficial distorted metal from the surfaces. The separate grains were easily traced through the specimen, and usually numbered three or four. Such was the starting material.

Specimens thus prepared gave films of which Fig. 3 is typical. The film corroborates our idea of few orientations. Next, moderate cold-work was done upon the

[1] CHEM. & MET. ENG., vol. 25, No. 14, p. 657 (Oct. 5, 1921).



FIGS. 3 TO 6. SPECTOGRAMS OF ALUMINUM (ABOVE) AND COPPER

Fig. 3. Coarse grained as cast.
Fig. 4. Moderately worked.
Fig. 5. Severely worked.
Fig. 6. Severely worked and annealed.

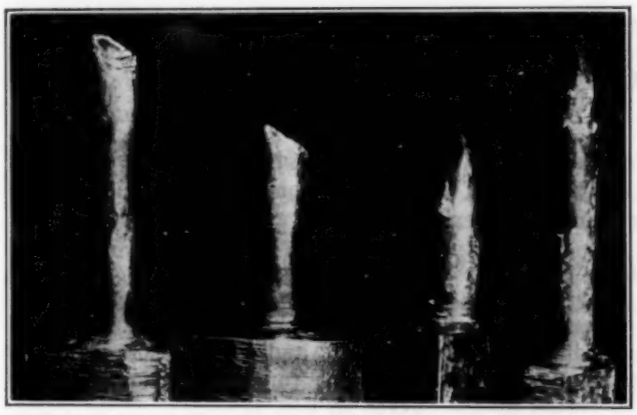


FIG. 7. WEDGE-SHAPED TENSILE RUPTURE CHARACTERISTIC OF SINGLE-GRAIN SECTIONS OF DUCTILE METALS

specimens by rolling to one-fourth or one-fifth their original thickness, and the original grains, much elongated, were revealed by etching. Spectrograms of this rolled metal were similar to Fig. 4, indicating some new orientations, even though the rays struck only about one-fifth the former area. (The beam of X-rays strikes upon the same surface area of the metal after elongation as before deformation. Hence the opportunity for encountering different orientations is only a fraction as great as in the cast specimen.)

But when reduced to one-eighth original thickness, in the case of aluminum, and one-fifteenth, in the case of copper, the full patterns shown in Fig. 5 were yielded by the X-ray spectrometer. These patterns are characteristic of an extremely fine grained metal, with a very complete assortment of orientations at random, such as obtained from the finest powders.[9]

These cold-worked specimens were annealed to produce recrystallization and again placed in the spectrometers. The resulting films shown in Fig. 6 are characteristic of a material whose grains are perhaps 0.005 or 0.010 in. in diameter. (There are not sufficient grains in the orientations for reflection to give continuous bands, and we may infer that there is a great reduction in number of orientations by the annealing.

The directional properties of single grains were strongly brought out in observations incidental to these experiments. Sykes[10] observed single grain sections of molybdenum wire to give wedge-shaped rupture ends in tensile strength above 300 deg. C. This has been found true for both copper and aluminum at ordinary temperature. Two views of a broken test-piece of copper are shown in Fig. 7. The single grains may be seen faintly etched on the specimen. During the test each grain deformed in its own particular manner; some were much more depressed than others, the boundary offering greatest resistance to deformation.

In rolling such material, however, the directional tendencies of the grains were most clearly seen. Some shifted to the right, some to the left; some elongated, some widened. This led the authors to press a specimen of large grains between lead plates. The different grains were thrown into bold relief but the boundaries seemed always to resist compression most strongly.

After observing the directions of favored slip in a grain the question naturally arises, "Along what atomic planes does slip preferably take place?" If it be the planes of widest separation, then for copper and aluminum it will occur along the planes designated 1-1-1 by Miller indices, of which there are four systems in any grain. For iron the greatest spacing is between successive 1-1-0 planes, of which there are six in any grain. This inference seems to be correct, judging from X-ray spectrometry, although Howe mentions the 2-1-1 planes in this connection. Experiments are under way in the authors' laboratory to show these favored slip planes conclusively.

A striking evidence of the development of mixed orientations by cold-work is seen in Fig. 8, in which is shown at 300 diameters a unicrystal tungsten wire twisted cold several turns. The specimen, prepared and photographed by P. P. Tarasov, Cleveland Wire Division, National Lamp Works, was polished and etched along a longitudinal section through the axis. According to Howe, etching is most vigorous when progressing normal to the 1-1-1 plane. In this case we seem to have a change of orientation every 90 deg. of turn.

The continuity of deformation is clearly seen here. The steps by which slip takes place must be quite small, and, most important, fairly regular. The lighter-etched areas the authors believe are the cube faces (1-0-0 planes). Such a specimen as this would in all probability give an X-ray film showing all orientations present. In fact the method described above has been applied to coarse-grained tungsten ingot and wire produced from it, with the same results.

[9] It is true that one line of the face-centered patterns is virtually absent from these films, but it is a very weak one at best and offers no ground for denying chaotic orientation in the specimen.

[10] *Trans.* Am. Inst. Min. and Met. Eng., January, 1921.

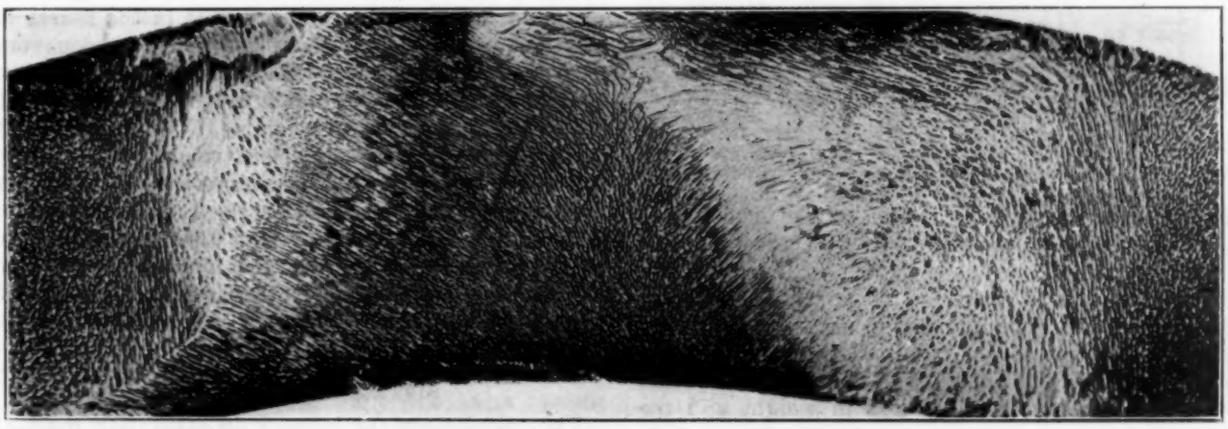


FIG. 8. SINGLE GRAIN IN TUNGSTEN WIRE, TWISTED COLD, POLISHED AND ETCHED. 300 ×. CONTINUOUS CHANGE IN ORIENTATION BY ROTATION OF CRYSTAL BLOCKS

Studies in Colorado Shale Oils—B*

Secondary Oils Obtained From a Representative Colorado Shale Oil by Successive Distillations at Atmospheric Pressure—Character and Composition of These Decomposition Products and of Their Parent Material

BY ARTHUR J. FRANKS

ALTHOUGH the work done thus far on the study of Colorado shale oils, as described by the author in this magazine,[10] is of a preliminary character and cannot be expected to yield information that is entirely specific nor data which are in themselves sufficient for the deduction of many very definite conclusions, it does bring to light a number of prominent phenomena which are of considerable interest as well as importance. One cannot study the curves (Figs. 1 to 4, pp. 732-733) as a whole without observing certain persistent relationships and drawing therefrom a number of conclusions, some of which may be vague and merely suggestive, while others are quite definite.

The outstanding combination of phenomena met thus far is that of an increase in saturation, lowering of vapor temperature and specific gravity, loss of nitrogen and sulphur and the formation of coke and gas that accompanies a cracking distillation of the crude oil and its heavy distillates. The various losses as well as saturation increases are presented in Table III (p. 734). All calculations are based on a 1,000-c.c. sample of the original crude oil. The coke and gas losses are

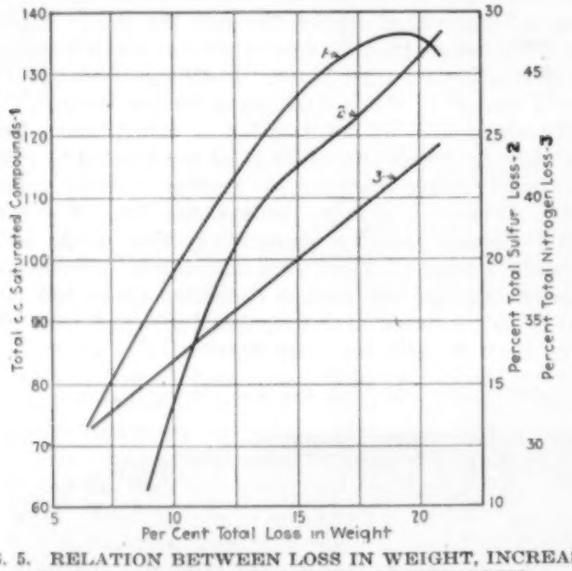


FIG. 5. RELATION BETWEEN LOSS IN WEIGHT, INCREASE IN SATURATION AND LOSSES OF NITROGEN AND SULPHUR

expressed in percentages by weight of the crude. The sulphur and nitrogen losses are given in percentages of their respective total weights present in the crude oil. The loss in volume is expressed in percentages of that of the original oil. The increase in saturation is given in cubic centimeters in one case and in percentages by volume of the original saturation in the other. The relationship between the total loss in weight and the total increase in saturation, and total losses of nitrogen and sulphur during the four distillations is well illustrated by the curves in Fig. 5.

Loss in Sulphur and Nitrogen During Successive Distillations

From the calculations in Table III and the curves it is evident that most of the decomposition, loss of sulphur and nitrogen and increase in saturation occurs in the first two distillations. More than three-fourths of the nitrogen loss but only about 40 per cent of the sulphur loss occurs in the first distillation. In the second distillation only about 11 per cent of the total nitrogen loss but about 25 per cent of the sulphur loss occurred. Hence there does not seem to be any constant relationship between the amounts of sulphur and nitrogen lost during the decomposition of the more unstable material. Consequently the results indicate that the nitrogen and sulphur in these very unstable oils are present in more than one class of compound. The character of the losses suggests that this easily decomposed unsaturated material is probably made up of very heavy nitrogen compounds, sulphur compounds and those containing both nitrogen and sulphur.

The nitrogen and sulphur losses in the third distillation are small and practically the same. This suggests that the more stable, heavy oils that decompose contain both nitrogen and sulphur. However, it is practically impossible to obtain any definite information from the behavior of the oils on distillation and the losses, because there is now no doubt that there is a recombination of these elements, as the analyses of the new oils show. Hence the actual amount of decomposition cannot be exactly measured. The losses are merely a measure of the difference between the total amounts recovered and those originally present. Therefore but little further information is available through a continuation of the present methods of investigation.

The losses of sulphur and nitrogen in the fourth distillation are less than those found in previous ones. They tell nothing more than that the sulphur and nitrogen compounds present in the distillates after four distillations are very stable. Continued distillations under the same conditions would probably effect neither greater nor less decomposition of these substances than that observed in the last distillation. A study of all other losses during the four distillations shows that what is true of the nitrogen and sulphur compounds is true of any other unstable constituents present in the oil.

Increase in Saturation of Distillates During Successive Distillations

The calculations for increase in saturation must dispel any doubts as to whether new saturated hydrocarbons are formed by the cracking of unstable material

*For Part A of this article see CHEM. & MET. ENG., vol. 25, No. 16, 1921, p. 731.

[10]CHEM. & MET. ENG., March 30, July 13 and Oct. 19, 1921.

in the heavy oils and prove that the increase is not merely due to a loss of unsaturated substances which would, of course, tend to produce the same result. For this reason the difference between the percentage saturation of the crude oil and that of the distillate is not a true measure of the saturated compounds formed during the distillation. Hence the actual volume of new saturated hydrocarbons was calculated in c.c., and is the sum of 100 times the products of percentage saturation and volume of each fraction. About 70 per cent of the total new saturated compounds formed were produced during the first distillation, and at the expense of only 44 per cent the total loss in weight and volume. In the second distillation only about 25 per cent were produced at the expense of about 28 per cent of the weight loss and 25 per cent of the volume loss. In the third distillation but 7.5 per cent were formed at the expense of 19 per cent of the weight loss and 20.7 per cent of the volume loss. In the fourth distillation there was no longer an increase but a loss of 3 per cent of the total saturated compounds formed, at the expense of 8.7 per cent of the weight loss and 9.8 per cent of the volume loss. Hence there is no constant ratio between the loss in weight and the increase in saturation.

There is a definite relationship, however, in which the total amount of saturated compounds formed varies with the loss in weight of oil according to a constantly decreasing ratio. This relationship is well illustrated by the curve in Fig. 5, in which the total increase of saturated compounds (in c.c.) is plotted against the total percentage loss in weight of oil. The maximum saturation is shown very clearly, as well as the fact that further distillations would result in a marked decomposition of the saturated compounds. It is very important to know that the saturation cannot be increased indefinitely by distillations at atmospheric pressure and that the limit is reached after the third distillation. Since the first of these distillations was made with the aid of hydrogen, it is very probable that the limit would be reached practically by two ordinary, destructive distillations.

Formation of Secondary Products During Distillation

In order to secure more information as to the extent of decomposition and light oil formation and the general character of the cracked oils, the data in Table II (p. 733) were obtained. Since there can no longer be any question that *D* is a secondary product not present in the crude oil and that it is a part of the distillate formed during the cracking of the heavy residue *B*, all the compounds present in *D* must also have been thus produced.

The analysis of *D* brings to light some rather surprising facts. It contains 49.2 per cent of saturated hydrocarbons, 2.8 per cent of aromatics, 12 per cent of organic bases and 38.8 per cent of unsaturated compounds, most of which are olefines, because the other unsaturated compounds seldom amount to more than 1 or 2 per cent. Hence this secondary oil contains more saturated hydrocarbons and less olefines than *A*, a primary distillate that boils within the same temperature range and has practically the same specific gravity. The saturated portion of *D* contains 6.0 per cent of aromatics. The remainder must be composed almost entirely of paraffins, because its aniline point is over 70 deg. C. The only other saturated hydrocarbons which could be present are alicyclics, or napthenes. They cannot have been present in very great amount; otherwise the aniline point could not have been so high as the one determined. Chavanne and Simon[11] have shown that paraffins may be differentiated from napthenes by the temperature above which they are completely miscible with aniline. This temperature is about 70 deg. C. for paraffins and about 30 to 50 deg. C. for napthenes. Hence the above conclusion is the only logical one.

Percentage of Decomposition During Successive Distillations

The lighter secondary oil (*D*) contains about 50 per cent of saturated hydrocarbons and about 50 per cent of other compounds. It is also known that *D* amounts to 10.8 per cent of the original oil, or 17.4 per cent of the oils in *B* that are not saturated, and that *D* was formed at the expense of 20.8 per cent of the volume of this material. This accounts for a decomposition of 38.2 per cent of the labile portion of *B* by a single distillation, since the volume of oil lost plus the volume of oil recovered should be equal to the total volume of oil decomposed, assuming that no intermolecular changes such as polymerization or depolymerization occurred. The increase in saturation of *E* over *B* is 54 c.c., which means that 54 c.c. of the new saturated compounds in *E* was formed by the cracking of *B*. Hence *E* also contains a large amount of secondary products, all of which cannot be exactly determined. But since the cracking produced about equal amounts of saturated and other oils in *D* and since the amount of secondary unsaturated and basic substances in the heavy oils is at least equal to or more than that of the saturated hydrocarbons, it may be safely assumed that at least 54 c.c. of oil other than that which was saturated was produced at the same time, or a total of at least 108 c.c. Hence the sum of all the secondary products recovered and the oil lost amounts, in a single distillation, to a minimum of 55.7 per cent of the labile and unsaturated oils in *B*. But since the ratio between the saturated and other compounds in the heavy fractions of the secondary oils is probably nearer to 1:2 or 1:3 than 1:1 (according to the saturation for the distillates from the fourth distillation above 276 deg., and assuming the theory to be correct that the greater part of these distillates is new oil), it is more probable that closer to 65 or 70 per cent of the labile oils decomposed during the one distillation. This indicates, therefore, that at least 44 and perhaps as much as 50 to 60 per cent of the distillates (aside from the original saturated compounds) produced from *B* and found in *C* are entirely new oils and were not present in the crude.

If the same calculations are made for the oils for the fourth of the first series of distillations, the decomposition will be found to have been about 70 to 85 per cent of the unsaturated and basic heavy oils. Hence the new oils produced from that material form at least 57 and probably as much as 85 per cent of the oils from the fourth distillation.

That the extent of the decomposition is at least as great as has been indicated may be confirmed convincingly by a further study of the nitrogen and sulphur losses. Since the total loss of nitrogen by four

[11] *Comptes rend.*, vol. 168, pp. 1111, 1324; vol. 169, pp. 185, 285 (1919)

distillations was 7.65 g., the weight recovered in the secondary oils (to 276 deg.) only 1.96 g. and the weight in the undistilled crude (above 276 deg.) 15.68 g., then the total decomposition of nitrogen compounds was at least 61.3 per cent. If the amount of nitrogen in the secondary products above 276 deg. could have been determined, it would have raised the amount of decomposition to probably 80 or 85 per cent of the nitrogen compounds in the crude above 276 deg., because most of the nitrogen is in the heavy oils, whereas only that in the lighter portion could be determined with certainty. The total sulphur loss was at the same time 1.91 g., the known amount recovered 1.02 g. and that in the undistilled crude 4.64 g. Hence the decomposition of sulphur compounds amounted to a minimum of 63.1 per cent of those present in the original residue of the crude oil above 276 deg. Although these percentages are perhaps not exact, due to the fact that all the compounds of either nitrogen or sulphur may not contain the same number of nitrogen or sulphur atoms, they represent averages which are sufficiently accurate for the present considerations and help to confirm the calculations made in the preceding paragraph and the conclusions drawn therefrom.

Verifying the Production of Secondary Oils by Varying the Distillation Procedure

Since it is very important as well as interesting to know conclusively whether the distillates from the heavy oils are actually new products and whether the decomposition is as great as the results thus far attained indicate, another sample of *B* was distilled in a somewhat different manner than before. The purpose was to distill until cracking commenced, separate the primary distillate, and subject the remainder to a slow distillation in order to crack as much of the labile material as possible in a single operation without attacking appreciable quantities of the saturated hydrocarbons. The secondary oils could then be separated at the temperature at which cracking began. Since they would be almost free from the primary oils, a clearer view would be obtained of the extent of the decomposition and the changes produced in the unstable substances.

A 300-c.c. portion of *B* was distilled as before with a few exceptions. A shorter condenser was used, and it was held in a vertical position. A short, tubular separatory funnel was attached, by means of a two-hole rubber stopper, to the end of the condenser tube to serve as a gas trap so that the distillate could be drawn off as desired without permitting the escape of gas formed during the distillation. A T-tube, placed in the other hole in the stopper and closed at one end with a piece of rubber tubing and a pinch cock, conveyed the gas to bottles, where certain constituents could be removed. It also served as a safety device to prevent the sucking back of liquid from the bottles. The first bottle contained a saturated solution of copper sulphate acidified with 10 per cent of sulphuric acid. This solution absorbed the hydrogen sulphide and ammonia. A second bottle contained a solution of silver chloride in ammonia, which was used to absorb any acetylene that might have been produced. The gas then passed into a large test tube surrounded by cold water and containing 10 c.c. of bromine and 4 c.c. of water, to absorb ethylene and its gaseous homologues. The levels of the liquids in the various containers were so adjusted as to produce a pressure of only about 2 cm. of water in the distillation flask.

The pinch cock was not closed until the air was expelled from the flask. The distillation was continued to 320 deg., when a slow but steady stream of gas began to bubble through the liquids in the bottles. This showed that cracking began in earnest at this temperature, although bubbles appeared at irregular intervals before 300 deg. All the distillate was now permitted to run out of the trap and into a graduate, where it was measured. It was labeled "*A'*," and preserved for analysis.

The rest of the distillation was made at a slower rate (one drop every two seconds) until there was no further increase in the amount of condensate. The trap was again drained and the oils measured. This cracked distillate was called "*C'*." A portion was withdrawn for analysis and the remainder distilled in the usual manner. The oils which came over up to 320 deg. C. were separated, measured and labeled as "*D'*." The residue above 320 deg. C. was called "*E'*." The data from the distillation, together with analyses and calculations, appear in Table IV. The temperature curves for the distillation appear in Fig. 1 (p. 732). The wash liquors will be considered later.

TABLE IV. DATA FROM DISTILLATION OF B.

Distillate	Per Cent Yield	Sp. Gr.	Per Cent Sat.	Total Sat. C. c.	Weight, G.
A'	23.3	0.892	32.4	75	208
B'	46.7	0.978	1.1	5	457
C'	33.1	0.882	39.1	129	292
D'	19.8	0.848	47.4	94	168
E'	13.3	0.932	26.9	35	124

Total weight loss: 18.2 per cent of original oil (or 35.3 per cent of *B'*)

Loss in volume	13.6 per cent of original oil.
Volume of new oils in *D'*	19.8 per cent of original oil.
Volume of new saturates in *E'*	3.0 per cent of original oil.
Volume of other new oils in *E'*	8.4 per cent of original oil.
Total volume of oil decomposed	44.8 per cent of original oil.
Original volume of basic and unsaturated oils in *B'*	46.2 per cent of original oil.
Total decomposition of unsaturated and basic oils in *B'*	97 per cent
Secondary, or new oils in *C'*	94 per cent

Production of Secondary Oils Verified

The results in Table IV furnish incontrovertible evidence of the truth of previous calculations and deductions and of the theory that the very heavy oils decompose almost completely into new products. It is also conclusively proved that these unstable and unsaturated and basic oils are the actual source of the saturated hydrocarbons in the secondary distillates. There can be no doubt that *D'*, which is 60 per cent of *C'*, is a new oil not present in the crude. The same is true of the 3.0 per cent of saturated compounds in *E'*. The 8.4 per cent of the remaining secondary oils in *E'* were calculated from the ratio between the new saturates and the unsaturated portion of *E'*. Hence it was here assumed that all of *B'* decomposed, with the exception of saturates; which seems to be the very question for which proof is being sought. However, the assumption was made for only a minor portion of the distillate. It is justified here because the decomposition amounts to 85 per cent, even if the ratio is assumed to be 1:1, which must be greater than the true ratio, because the latter decreases with increase in the boiling point of the oil and is 1:1 for the oils below 254 deg. Even with a decomposition of 85 per cent of the labile oils of *B'* the ratio is about 1:2.4, which makes the secondary unsaturated oils in *E'* amount to 7.2 per cent. Hence the assumption cannot be very far from the truth. In either case the final results—

namely, 97 per cent for the amount of decomposition of the unstable oils above 320 deg. and 94 per cent for the quantity of new secondary oils in this distillate —are sufficiently exact for present considerations.

The above experiments also establish the fact that there is no appreciable cracking of the oils boiling below 320 deg. when they are distilled at atmospheric pressure (which is about 615 mm. in Golden). Decomposition begins in earnest at about that temperature and becomes more and more pronounced as the temperature rises. The temperature of the oil necessary to give a vapor temperature of 320 deg. varies, of course, with the rate of distillation and the size and shape of flask used, but was about 375 to 380 deg. in this case.

It may be mentioned here that the unstable bitumens contain oxygen in small amounts, in addition to sulphur and nitrogen. This is shown by the fact that tiny drops of water have always been found in the secondary oils. The water was, of course, formed by the cracking of compounds which contain oxygen and hydrogen.

From what has already been said there can be no further doubt that the heavy fractions of crude Colorado shale oils are unstable, unsaturated, contain sulphur, nitrogen and oxygen, that they are largely decomposed by two or three ordinary distillations (or a single slow one) at atmospheric pressure and with a loss of much nitrogen and sulphur into much more stable products of simpler composition, lower specific gravity and higher saturation, and that the lighter of these products (below 276 deg.) consist mainly of paraffins, olefines and nitrogen bases with some aromatics, diolefines and compounds of sulphur and nitrogen.

Mechanism of the Reactions During Distillation at Atmospheric Pressure

Since the nature of the labile material is very complex and the products of its decomposition so numerous, it is very difficult to advance a satisfactory explanation or even a comprehensive hypothesis for the mechanism of the reactions that must have occurred. Considering that the loss in weight is more than 35 per cent of the unstable oils and that some aromatics and nitrogen bases were formed, it seems that a rather complete disintegration of the heavy molecules took place with a subsequent recombination of some of their parts, rather than a mere splitting-off of certain atoms or groups so as to leave the main, catenary or nuclear structure. Perhaps both kinds of decomposition occurred. In any case, the resulting products should be of a more stable character, such as that actually observed. Hence the formation of saturated and stable compounds from unsaturated and labile substances is not only possible but reasonable, in spite of the fact that the cracking of petroleum gives products of a lower saturation.[12] The diverse results are merely due to the inherent differences in the parent material. As a matter of fact, energy and thermochemical considerations would lead one to expect that the more unsaturated and unstable the oil the more readily should it decompose into products of greater stability. The results of cracking heavy fractions of shale oils are, therefore, in harmony with modern theory.

It was hoped that some of the data might serve to throw a little light on the reactions which occur during the cracking of the unstable oils. For this reason attempts were made to separate ethylenes and acetylene from the gases. Since the gas contained much hydrogen sulphide and some of it went over into the silver solution, it was necessary to redissolve the precipitate in strong HCl and pass the gas through three bottles of acid copper sulphate solution, one of sodium hydroxide and then into a fresh ammonical silver chloride solution. No precipitate was observed in this solution; hence no acetylene was present in the gas.

Since about 10 c.c. of bromides were formed, the gases must have contained olefines. A satisfactory fractionation of such a small amount of liquid was, of course, not possible. However, the series of boiling points observed during two rough fractionations showed the presence of bromides of ethylene, propylene and butylene and other heavier bromides which decomposed during the distillation at atmospheric pressure. The presence of these compounds was roughly confirmed by specific gravity determinations on three fractions.

The fact that much of the gas was not absorbed by any of the solutions used shows that it probably contained hydrogen and members of the methane series.

The presence of ethylenes in the gas indicates that a rather severe decomposition might have occurred. The presence of aromatics in the distillates confirms this deduction. Yet the absence of acetylene in the gas suggests that the aromatics were formed by a splitting of heavy polycyclic molecules, or heavy aromatic derivatives, rather than by a polymerization of acetylene. But then there is also the possibility that the acetylene either polymerized completely or combined with some other unsaturated hydrocarbon and consequently would not be found in the gas. It is obvious, therefore, that the evidence from these experiments is far too meager to serve as a basis for any intelligent considerations. Since the author does not desire to indulge in any mere speculations, a decision of the question must be left for further investigation.

Nature of the Colorado Shale Oils

In concluding the discussion of results from this work the author wishes to make a few remarks concerning the nature of the crude shale oils, their distillates and the organic material in the shale which is the base of these products. It is already well known that true Colorado oil shales actually contain no oil, since only insignificant amounts of organic matter can be extracted with solvents. A destructive distillation is necessary before oil can be obtained. Therefore the oil is, of course, different from the parent substance. It has also been established that the less the decomposition of this material during the carbonization of the shale the more unsaturated and unstable, and the heavier is the oil.[13] This is evident from the fact that oils of this character are produced when steam and inert gases, such as hydrogen, are used to minimize cracking, and because only the oils which have suffered extensive cracking are at all stable, saturated and contain many of the lighter constituents. The questions are then: Where do the light, saturated and stable oils of the crude originate? Are they entirely secondary products from the decomposition of the oil, or primary products of the carbonization of the "kerogen," or organic material in the shale? Are all the saturated hydrocarbons produced by secondary reactions, or does the original kerogen contain some of them? Since the oil is more and more unsaturated as it is produced with

[12]Rittman and Twomey, *J. Ind. Eng. Chem.*, vol. 8, p. 20 (1916).

[13]Botkin, CHEM. & MET. ENG., vol. 24, p. 876 (1921).

less and less decomposition, there seems to be no doubt that the kerogen itself is very unsaturated. It is the writer's opinion that the substance which yields the saturated oils contains no saturated compounds whatever. If that is the case, then the latter were all produced by secondary reactions.

Theory of the Formation of Oil From Shales

The next question which arises is: If saturated hydrocarbons are produced only by secondary decompositions, what is the nature of the primary products and how were they formed? If we consider the results reported in the preceding pages, the answer seems evident. The primary products are, or are similar to, those heavy, unstable fractions of the crude oil which decompose during distillation. They represent that portion of the organic matter in the shale which distilled over without cracking on account of the lowering of the vapor pressure in the retort by the presence of lighter constituents and gas produced during the cracking of some of the primary oil. The presence of such large amounts of this primary bitumen in the crude oil might easily be accounted for by slow rates of the cracking reactions, and hence incomplete equilibrium under the conditions of retorting.

But these heavy primary oils are soluble in the usual organic solvents, such as carbon bisulphide, ether, benzene and the like. The original kerogen of the shale is almost insoluble. If it is assumed that this unstable material has the same or similar composition as the kerogen, how can this difference in solubility be explained? In the writer's opinion, the transformation from insoluble to soluble substances might easily be accounted for by a depolymerization, or some similar reaction, in which the complexity of the very heavy molecules is reduced without a change in composition. Results of this kind have been observed by Engler and Lederer.[14] Further research on this theory is necessary.[15]

On the basis of the evidence and considerations presented herein a quite satisfactory theory can be formulated to explain the formation of oil from shales of the Colorado type and the manner in which lighter and more saturated products can be obtained by cracking distillates of this crude oil. The carbonization of the shale must occur in two stages: (1) A depolymerization of the organic matter, or kerogen, to complex, heavy, unsaturated and unstable oils which do not distill at atmospheric pressure without decomposition; and (2) a cracking of this primary material into simpler oils of lower molecular weight, greater stability and containing up to about 50 per cent of saturated hydrocarbons. When the decomposition is only partial the result is an oil similar to the ordinary crude oils from Colorado shales. Complete decomposition of the primary oil yields a product similar to the distillate from the fourth distillation, or *C'*. By varying the conditions that exist during the retorting of the shale, oils may be obtained which vary from products which are practically entirely primary to those which are completely secondary. Hence careful control of physical conditions is of importance in commercial operations.

[14] Engler-Höfer, "Das Erdol," vol. 1, p. 30 (1913).

[15] Since this paper was written an article has appeared by R. H. McKee and E. E. Lyder (*J. Ind. Eng. Chem.*, vol. 13, pp. 613 and 678), who have recently investigated the thermal decomposition of oil shales. Their conclusions are in accord with those presented in the present contribution. The theory is much strengthened by the fact that our conclusions were arrived at by different methods of investigation.

Summary

1. The changes produced in a Colorado shale oil by successive distillations at atmospheric pressure have been investigated through a study of the specific gravities, vapor temperatures, saturation, sulphur and nitrogen in 10 per cent fractions. The light fractions are very stable and are not altered to any appreciable extent by redistillations. The heavy fractions are unstable and decompose easily. Most of the decomposition occurs during the first distillation.

2. Each decomposition is attended by the following phenomena: (*a*) The formation of gas; (*b*) a decrease in the weight and volume of oil recovered; (*c*) an increasing stability of the distillates; (*d*) a lowering of the specific gravity; (*e*) a loss of sulphur; (*f*) a loss of nitrogen, and (*g*) an increase in the amount of saturated hydrocarbons in the distillate. After the third distillation has been made the total volume of saturated compounds begins to diminish.

3. The light and middle fractions of the crude oil are very stable. Although decomposition commences when the vapor temperature is about 300 deg. C., it is not appreciable until about 320 deg. is reached.

4. It has been proved that new saturated hydrocarbons are formed during cracking distillations of crude oils and that the heavy, unsaturated bitumens in the oil (boiling above about 320 deg.) are the source of these saturated compounds.

5. The lighter secondary product (boiling below 276 deg.) consists mainly of paraffins and olefines, together with lesser amounts of organic nitrogen bases, aromatics, diolefines, and compounds of sulphur and nitrogen. It is quite similar, therefore, to the primary light oil which is found in the crude products.

6. The heavy, unstable bitumens in the crude oil have been shown to be very complex substances which contain sulphur, nitrogen (in large quantities) and oxygen, but practically no saturated hydrocarbons.

Evidence has been presented which supports the theory that these unstable compounds are merely intermediate products of the carbonization of oil shales. They decompose easily, and practically completely, when subjected to destructive distillation at atmospheric pressure, yielding the stable, secondary products.

7. A theory has been presented to explain the formation of oil from Colorado shales. According to this theory, heat first effects a depolymerization (or some similar transformation) of the kerogen to less complex, heavy, unstable and unsaturated compounds which resemble that fraction of the crude oil which boils above 320 deg. These labile oils then decompose to a varying degree, with the formation of simpler, stable products. It is this secondary decomposition which accounts for the presence of the light constituents in crude oils.

Acknowledgment

The author takes this opportunity to express his appreciation of the assistance rendered by C. P. Hackett, who made the distillations and most of the analyses recorded in this paper. Thanks are also due to J. P. Bacca, who made a number of the sulphur determinations. The valuable criticisms and suggestions of Dr. Victor C. Alderson and Prof. A. H. Low were of great aid in the preparation of the manuscript, and are acknowledged with pleasure.

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Influence of Mass in Heat-Treatment*

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IT IS well known that the mass of a piece of steel which has been heat-treated greatly influences the physical properties of the steel, but very little has been done to ascertain whether the law of the relation between the mass and the physical properties can be mathematically determined. With this idea in mind, the writer has prepared the following paper, the object of which is to point out that such a law exists and that it can be mathematically determined.

In the *Journal of the American Steel Treaters Society*, Vol. 1, No. 1, October, 1918, I wrote an article under the heading, "Mathematical Discussion of the Influence of Mass on Heat-Treating," showing that the product of the surface per pound of steel (S) and diameter or thickness (D) is respectively $S \times D = 7.062$ (for plates), 14.125 (for rounds) and 21.185 (for spheres), these constants being in the ratio 1 : 2 : 3. The equation $S \times D = C$ represents a hyperbola in which the asymptotes are rectangular.

Not having any actual data at hand at that time, it was decided to search for some which would define somewhat closer than heretofore the mathematical relationships which exist in regard to this question. In October, 1920, the report of the British Engineering Standards Association was published and it was in this report, No. 75, that the writer found some very reliable data affording an excellent opportunity for this study.

The analysis of one of the steels tested in the British investigation was as follows:

C	Mn	S	P	Si	Ni	Cr	W	V
0.45	0.78	0.02	0.025	0.32	Nil	Nil	Nil	Nil

The accompanying test results were obtained from bars of this steel rolled to 3¼ in., 2⅜ in., 1¼ in. and ⅞ in. diameter respectively, and machined to 3 in., 2½ in., 1⅛ in. and ¾ in. diameter respectively. The bars were heat-treated before machining to test-piece dimensions.

The figures in Tables I and II used in this discussion are considered by the British committee as representing the true physical properties of the steel after the specified heat-treatment had been carried out. In this work there were four investigators, one of whom was the manufacturer of the steel; each checked his results in triplicate. The results of the investigators agree very closely on this steel and therefore are considered as representing within experimental error the true properties of metal of this analysis. It should be kept in mind that the results of these tests represent the physical qualities of the center portions of the rounds and thereby avoid any harmful effects which could be ascribed to the steep gradient of the hardness penetration which exists near the surface. The rolled bars were cut to standard lengths for tensile and Izod tests, the length of the tensile test-bar being 6 in. and that of the Izod 8¼ in. In the case of the 1-in. and ⅞-in. round rolled bars, the tensile test-pieces were cut 9 in. long, in order to afford a better grip for the testing machine; in cases where very great hardness was expected after heat-treatment, the tensile pieces of the larger diameters were cut 10 in. long. After being cut, all the test-bars were centered in an automatic centering machine in order to get the test-pieces machined truly parallel with the cores of the test-bars.

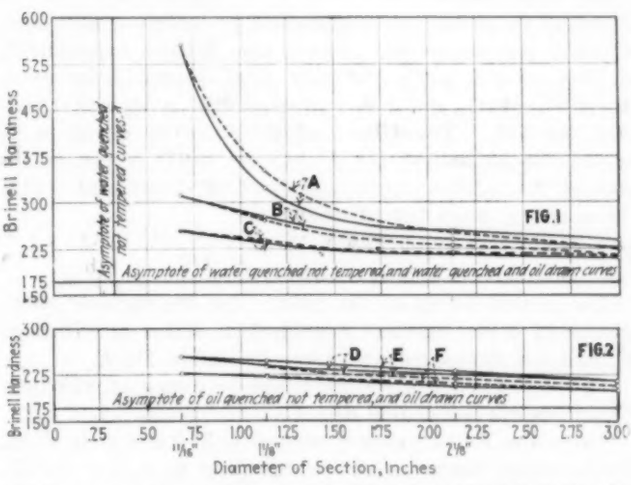
*A paper presented before the Indianapolis meeting of the American Society for Steel Treating, Sept. 23, 1921.

TABLE I. TESTS ON BARS OF VARYING MASS
Water-quenched from 870 deg. C., and not tempered

Diameter of Section Treated, In.	Maximum Stress	Yield Point	Elongation	Red. of Area	Izod Impact	Brinell
¾	269,000	258,000	3.0	4.0	3	555
1⅛	150,000	95,000	12.0	28.0	14	321
2½	125,000	83,000	18.0	43.0	16	255
3	116,000	76,000	23.0	54.0	24	241

TABLE II. TESTS ON BARS OF VARYING MASS
Oil-quenched from 870 deg. C., and not tempered

Diameter of Section Treated, In.	Maximum Stress	Yield Point	Elongation	Red. of Area	Izod Impact	Brinell
¾	130,000	96,000	18.0	50.0	22	255
1⅛	125,000	83,000	20.0	49.0	27	241
2½	116,000	76,000	23.0	54.0	24	228
3	110,000	72,000	23.0	55.0	26	217



FIGS. 1 AND 2. BRINELL HARDNESS IN FUNCTION OF SECTION AND HEAT-TREATMENT

Fig. 1—Water-quenched. Fig. 2—Oil-quenched. The unbroken lines were plotted from data given by the British Engineering Standards Association for samples, analyzing C 0.45, Mn 0.78, P 0.025, S 0.02, Si 0.32, and using the formula $B = \frac{nC}{D-d} + b$.

The Brinell impressions on the fractured tensile tests were made upon flat surfaces produced by milling down the shoulder on a screwed end of each specimen to the level of the cylindrical test portion. Only Brinell numbers of the tensile test-pieces are given in this discussion, as they represent the actual hardnesses of the centers of the test-pieces and are geometrically identical.

Using Brinell numbers as ordinates and diameters of the quenched sections as abscissas, two sets of curves were plotted from the British figures as shown in Figs. 1 and 2. The Brinell hardness of any section is in direct ratio to the surface per lb. of steel: $B = nS$, n being a factor which is constant for each steel of a particular analysis. The equation for round bars $S \times D = 14.125$ can thus be written $B \times D = 14.125\ n$.

This last equation is a true one, but in its present form is unsuitable for our purpose, inasmuch as it does not take into consideration the asymptotes of the curves. It can be seen that the axes of the rectangular system of co-ordinates are not the asymptotes of the curves. The equation changed to take into account the asymptotes reads

$$(B - b) \times (D - d) = 14.125n; \text{ hence}$$

$$B = \frac{14.125n}{(D-d)} + b \qquad (1)$$

B is the Brinell hardness of any section desired; n is

a factor which is constant for each steel of a particular analysis, and which appears to be the square of the hardening capacity; D is the diameter of a section; b stands for the horizontal asymptote, which for this steel corresponds to a Brinell hardness of 175; d corresponds to the vertical asymptote of the hyperbola and whose value obtained from equation 1 is

$$d = D - \frac{14.125n}{(B-b)} \qquad (2)$$

The maximum hardness of this steel was taken to be that of an ½-in. section quenched in water, which gave a Brinell hardness of 555. Thus the ratio is 555 ÷ 175, or 3.17. Now $3.17^2 = 10$. Therefore for 0.45 carbon steel, $n = 10$.

With the discussion as it now stands, the following six curves are considered individually and their equations developed.

(1) 0.45 carbon steel quenched in water at 870 deg., C., and not tempered. From the British experiment, a ½-in. round section of this steel quenched in water at 870 deg. C. and not tempered had a Brinell hardness of 555. Therefore, substituting in equation 2, using the value 555 for B and ½ for D, there is obtained for d, the vertical asymptote, the value 0.317. Thus the formula for this curve is

$$B = \frac{(14.125) \times 10}{(D - 0.317)} + 175$$

Using this formula, the values for the Brinell hardnesses of other sections quenched in water at 870 deg. C. and not tempered are given in Table III-A.

(2) 0.45 carbon steel quenched in water at 870 deg. C. and tempered at 500 deg. C.

From the British experiment, B is 311 and D is ½ in. Substituting these values in equation 2, $d = -0.352$. The formula for this steel quenched as indicated and drawn at 500 deg. C. is $B = \frac{(14.125) \times 10}{D - (-0.352)} + 175$ and the Brinell hardness of other sections is given in Table III-B.

(3) 0.45 carbon steel quenched in water at 870 deg. C. and tempered at 600 deg. C.

From the British experiment, B is 255 and D is ½. Substituting in 2, $d = -1.072$. Therefore, the formula for this steel quenched as indicated and drawn at 600 deg. C. is $B = \frac{(14.125) \times 10}{D - (-1.072)} + 175$. Table III-C gives the hardness of other sections.

TABLE III. HARDNESS OF 0.45 C STEEL, QUENCHED IN WATER AT 870 DEG. C (See Fig. 1)

	— Brinell Hardness From — British Report			Brinell Hardness Computed by Formula		
	A	*B*	*C*	*A*	*B*	*C*
Dia. of Section, In.	Not Tempered	Tempered at 500 Deg. C.	Tempered at 600 Deg. C.	Not Tempered	Tempered at 500 Deg. C.	Tempered at 600 Deg. C.
½	555	311	255	555	311	256
1½	321	277	235	359	272	239
2½	255	241	217	253	230	219
3	241	229	212	228	216	210

TABLE IV. HARDNESS OF 0.45 C STEEL, QUENCHED IN OIL AT 870 DEG. C (See Fig. 2)

	— Brinell Hardness From — British Report			Brinell Hardness Computed by Formula		
	D	*E*	*F*	*D*	*E*	*F*
Dia. of Section, In.	Not Tempered	Tempered at 500 Deg. C.	Tempered at 600 Deg. C.	Not Tempered	Tempered at 500 Deg. C.	Tempered at 600 Deg. C.
½	255	255	229	256	256	229
1½	241	248	223	239	239	221
2½	228	228	207	219	219	210
3	217	217	202	210	210	204

(4) 0.45 carbon steel quenched in oil at 870 deg. C. and not tempered.

From the British experiment, B is 255 and D is ½. Substituting in 2, $d = -1.072$. Therefore, the formula for this steel quenched in oil as indicated and not tempered is $B = \frac{(14.125) \times 10}{D - (-1.072)} + 175$. Using this formula, the Brinell hardness of other sections quenched in oil and not tempered are given in Table IV-D.

(5) 0.45 carbon steel quenched in oil at 870 deg. C. and tempered at 500 deg. C.

From the British figures, B is 255 and D is ½. Substituting in 2, $d = -1.072$. Therefore, the formula for this steel quenched in oil as indicated and drawn at 500 deg. C. is $B = \frac{(14.125) \times 10}{D - (-1.072)} + 175$, and the Brinell hardness of other sections is given in Table IV-E.

(6) 0.45 carbon steel quenched in oil at 870 deg. C. and drawn at 600 deg. C.

From the British figures, B is 229 and D ½. Substituting in 2, $d = -1.947$. The formula for this steel is $B = \frac{(14.125) \times 10}{D - (-1.947)} + 175$. Table IV-F gives the hardness of other sections.

From the foregoing calculations it is apparent that the factors which control d in any carbon steel are the drasticity of the quenching medium and the extent of

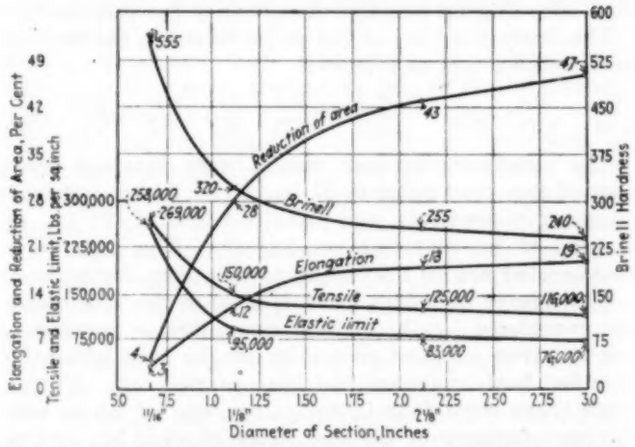


FIG. 3. PHYSICAL PROPERTIES OF 0.45 C STEEL, WATER-QUENCHED FROM 870 DEG. C., NOT TEMPERED

Plotted from data given by the British Engineering Standards Association.

the tempering operation. As the drasticity of the quench becomes less and as the degree of the tempering becomes greater, the vertical asymptote d moves toward the left into the second quadrant of the system of co-ordinates.

It is interesting to compare the Brinell curve with the curves of other physical properties, such as tensile strength, elastic limit, elongation and reduction of area. This has been done in Fig. 3 and shows a similar hyperbolic tendency of these curves. The Brinell and tensile curves run parallel, as is to be expected.

The figures given in this paper speak for themselves, and point to the possibility of mathematically predicting results which are to be expected in different sizes of heat-treated steel.

The author wishes hereby to express his appreciation for the aid rendered by his assistant, H. Blumberg, in the preparation of this paper.

Science and the Coming Agriculture*

Our Future National Strength Depends on Scientific Study of Soil Fertility—Weakness of Eastern Nations Directly Attributed to Lack of Fertilizer for Food Crops—Methods of Estimating Requirements—Definite Problems to Be Solved by the Chemist

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THE efficiency of individuals and nations depends on an ample supply of food, clothing, fuel and transportation, and a study of these subjects and their relation to the future of man's welfare is always interesting. History records the fact that the decline and fall of the Roman Empire was due to the decline of crop yields and the failure of agriculture. Rome poured out the fertility of her suburban lands through the great sewer—into the sea; after that she poured out the fertility of Italy into the sea; and later she poured into the sea the fertility of Europe, or so much of it as she could amass under her own control. The constant growth of population was accompanied by a corresponding decline of yield per capita and yield per acre. The prices of food products rose higher and higher and the poorer classes ate less and less and poorer and poorer food, and thus the vitality of proud Rome dwindled away. When the Vandals and the Goths made their way into the northern part of Italy, they did not find the sturdy Roman soldier of the fifth century before the Christian era, but an underfed, anæmic people with weak bodies, and the once glorious Rome perished with only a faint voice.

Undernourished Races Decline in Orient

The Oriental nations have developed populations out of proportion to the productive power of their soils, and their peoples are no longer efficiently fed. King estimates that there are provinces in China with a population of 3,480 per square mile, or an average of 240 persons, twenty-four donkeys and twenty-four pigs to every 40-acre farm—a small farm for even a single family in our own country. Whatever has been the unwritten history of China's ancient agriculture, she has in modern time exhausted every possible means to intensify production. Every canal channel, every available portion of her river courses, every sewer in the province—all are periodically scraped for every ounce of plant food to renew the producing power of the soil. The Chinese farmer is efficient. His methods are not scientific, but they are based on centuries of observation and experience. He uses practically no commercial fertilizer, and the soils in most of the fertile sections are out of balance—that is, they do not have the proper proportion of the various plant food elements to grow maximum crops. The nation as a whole has lost much of the individual initiative and lives a life of procrastination and vacillation. The people lack organizing ability in the larger sense and have little interest in outside affairs. Food in China is consumed dangerously near the point of production and drought and storms or other destructive agencies over even small areas bring on great suffering and loss of life. Much the same condition exists in India. The Chinese and Indians possess common characteristics, and it is because they both as nations have reached the final stage of agriculture.

Japan, with a slightly better system of transportation and a larger knowledge of scientific methods, manages to feed her people fairly well. Japan has a population of 2,349 per square mile, or more than three to the acre of her cultivated lands. She has practically exhausted her cultivable area and must expand in foreign countries if her population is to increase. In her efforts to maintain her soil fertility, she saves and returns to the land 1.75 tons of human excrement per acre annually for each cultivated acre in the kingdom. To this is added mud, animal waste and decaying vegetable matter to the value of $5 per acre. In this way the country reaches its maximum production all the time in order to maintain human life.

No data are available as to the calories consumed daily by the Chinese and the Indians. The Japanese dietary standard for a man performing ordinary muscular work totals 2,380 calories. It is estimated that the well-to-do class in the larger cities consumes 2,388 calories; that the coast region and middle classes in general consume 2,528 calories; and that the rural classes consume 2,002 calories. Rice supplies about half of the calories consumed; beef, fish, milk, greens, potatoes and pickled and dried radishes the remainder. It may be estimated that the ratio of these foods varies from a normal amount of meat, milk and fish in the best families to an almost exclusive diet of rice in the poorer rural sections, and the effect of this can be seen in the looks, stature and activities of the various classes of the people in the various strata of society. Very little meat is eaten in the Orient, a fact which may have direct relation to the life and progress of the people, and also their stature. Japan produces little livestock, her total pounds per capita being 4.21, as against 163.3 lb. per capita in the United States. As an acre of land will produce only so many pounds of meat, the Mongolian races have for hundreds of years been specializing on human beings, and with only reasonable success, because too many are now being grazed per acre.

European Nations Fertilize Lands

Western Europe set out to develop her agriculture on a different basis from the Orient. Germany, Austria, Belgium, France, Spain, Italy and the British Isles are densely populated as compared with the United States. With the great increase in urban population following the intensive industrial development during the last fifty years, and with the decreased emigration,

*Paper presented before the Chicago Section, A.C.S., Sept. 23, 1921.

the fields of western Europe have been called upon for much greater yields than was necessary before the coming of the towns and cities. In order to obtain the maximum production from their fields, these countries have made use of scientific research and its application to the greatest degree. Their farmers place great confidence in the recommendations of their agricultural experts, and as a consequence they make greater use of science in their farm operations. The principle on which they have developed their agriculture is "greater yield per acre and better crops and livestock." The United States up to a few years ago was developing almost too exclusively on the basis of greater production per man power, regardless of yields per acre. In this respect, Europe would maintain a larger population and feed and clothe them better.

United States Now Wasting Fertility

The following comparison places the United States at a disadvantage so far as agricultural efficiency is concerned. Although our country is fifteen times as large as Germany, we produce only the same amount of barley and not quite twice as much oats. Germany produces six times as many potatoes and twelve times as much rice. When the war broke out, Germany had 5,000,000 farms averaging 15 acres, and we had 6,340,000 farms averaging 138 acres. These German farms produced 40 per cent more wheat, rye, barley, oats and potatoes taken together than we produced. Within the last thirty years, Germany has increased her per-acre yield of rye from 15 to 29 bushels, while the United States increased only from 14 to 16; Germany increased her acre yield of wheat from 19 to 30 bushels, the United States from 13 to 15 bushels; Germany increased the yield of barley from 24 to 39 bushels, the United States from 24 to 24.3 bushels; Germany increased her acre yield of oats from 31 to 59 bushels, the United States from 28 to 30 bushels; Germany increased the yield of potatoes from 115 to 208 bushels; the United States from 98 to 100 bushels. Germany has an area equal to the three states Minnesota, Iowa and Missouri, and under normal conditions produces 88 per cent of her food requirements. With a population almost half as large as the population of the United States and with only one-fifteenth the land area, Germany shows an agricultural effieciency about six times that of the United States.

Method of Estimating

How is this scientific or efficiency farming measured? In trying to get an estimate on this point, one would naturally have to take into account such factors as improved preparation, tillage and cultivation, improved seed and breeds, and the new principle of increased soil fertility. The average yield of wheat in Belgium is 37 bushels per acre, and her average consumption of commercial fertilizers 270 lb. per acre. England, on account of her great industries and her limited farm area, is the great importing nation of the world. Yet her yield per acre of wheat is 33.4, as against our 14.8 bushels in the United States. England shows a yield of 29.1 rye, 43.5 oats, against a yield of 16.1 rye and 29.5 oats in the United States.

These higher yields in western Europe indicate a more intensive and scientific agriculture than we have been able to reach in the United States. We are at the present time on trial in our United States agriculture. We are either at a standstill or on the decline, so far as acre yield is concerned, in much of our area. With a sparse population and broad areas of uncultivated lands, a nation can choose between extensive and intensive agriculture, but with densely populated country there can be no choice. The intensive method must be followed. We of the United States have been a wasteful people. We have had too much land, and have moved on from state to state in search of the more fertile spots of land, and neglected to maintain the producing power of our conquered area. We have been practicing the soil-robbing method, and with the waste involved and with improved farm machinery our per capita production has exceeded that of Europe. This condition did not exist, however, when a large per cent of our population was still on farms.

Balance of Population and Fertility

Large populations and low crop yields do not go together. In this country our population is rapidly growing and we must more fully utilize nature's stores in our future development. Our national tendency has been to drift from the farm to the towns and cities, because of the great competition of industry with agriculture. Whether agriculture can be maintained on a high acre yield basis with a minimum number of producers is one of the unanswered questions of modern times. Whether the greatest yield can be obtained with farm machinery and large operation we have not yet learned. But that less than 50 per cent of our population are producers is sufficient argument that we are not likely to drift toward the conditions of the Orient. We shall likely maintain our share of the world's industries, and shall be required, if we do this, to make a more efficient farming country. In a way our industries, commerce and transportation have grown more rapidly and more efficiently than our agriculture. These factors must be balanced before we can count ourselves safe for efficiency in a broad national way.

Our population is increasing and our lands at the same time are being depleted. Our ditches are all lined with the fertility of the farms they were dug to drain. From our rivers we lose annually 500,000,000 tons of fertility, thereby diminishing our fertility at a rapid rate. Our sewer pipes are taking from our farms 50,000,000 tons of fertility annually. The crops that are removed from the soil, never to get back to the fields in the form of manure or any other form, take from our farm lands 30,000,000 tons of our fertility annually. In the face of these undeniable facts, our population will be, according to Dr. Edward M. East, of Harvard, more than doubled by the year 2020. At the same time he shows that according to our present methods of agriculture and our present rates of food and clothing consumption 197,000,000 is our ultimate population limit. After that point has been reached, our production and consumption will be on an equilibrium, granting that we utilize every acre of available land for farming purposes, and use it all approximately as we use our farm lands at this time.

Food and Clothing Crops

Our sheep must be used for clothing, and our cotton fields can never yield their place to food crops. In fact, they must be made to grow bigger crops, and more acres must be planted to cotton, as our population reaches nearer and nearer to the ultimate saturation point.

Just what per cent of our farm lands is required to grow the world's clothing no one has figured out, but whatever it is it can never give way to food production. In the case of cotton and sheep, we are growing food and clothing in one, which argues for a degree of efficiency that may be hard to match in growing plants exclusively for clothing. An advancing civilization requires better shelter and clothing as well as food, and there can be no other source for these than our agriculture. These features other than foods are not luxuries, but indices of civilization. They are guides to the progressiveness of nations. To have these and a wholesome system of transportation and commerce means the maintaining of a ratio of populations for production and for other vocations. What these ratios will ultimately be no one can predict, but they must be maintained. If our own people have any claim of superiority at this time, it is because we are better fed and clothed than most of the other nations. In the race for supremacy we shall hold out longer for this reason. But to maintain our place we must turn our attention to some of the great problems of the soil. We must make greater use of these foods we consume by giving greater directive force to our production agencies.

Technical Problems Involved

Let us then consider the scientific problems that lie before us. They can be solved only by the scientist. He may be a chemist, he may be a physicist, he may be an engineer. He must be a seeker of knowledge, he must spend his time in research. The basic problem is the ultimate maximum efficient production of food and clothing. The engineer has before him the salvaging of arid but potentially productive regions. He may have to control, conserve and portion out flood waters. He may have to resort to reforestation to control precipitation. We know the general results obtained by devastation of our forests—floods, with consequent erosion of surface fertility. Can our engineers develop a remedy? Granted that production can be obtained, the engineer still has one of the gravest of the problems before him—transportation. Production must seek the level of consumption. Transportation is the only means by which this can be effected and the costs are now in too many instances prohibitive. The engineer must research the operations of transportation, seeking to reduce the cost. The chemist has a field too in fuel efficiency or even synthetic fuels.

Chemist's Work, the Solution

The chemist's big agricultural problem is fertility. As a matter of fact very little is known as to the relative importance of the various elements of fertility. Is plant food more important than moisture? Will bacteria destroy soil toxins? We are still groping in the dark on soil fertility. We have data giving specific results of certain fertilizing experiments under one set of climatic conditions on a given crop and soil. But who has made any progress in determining why these results were obtained, or how can they be interpreted in connection with a different set of conditions?

True, our worries on plant food supplies seem to be largely over. For a time it seemed as if the supply of available nitrogen was rather definitely limited. In the past few years the progress made in the fixation of atmospheric nitrogen has opened up unlimited supplies of this element.

If we forget political and geographic boundaries, there is sufficient available potash now blocked out to supply the world for a long time to come. Undoubtedly new deposits will be discovered. The present industrial byproduct waste of available potash will be further studied and this product saved for agriculture. The vast supply of potash in our shales and feldspars and other igneous rocks will remain as a reserve supply in case other sources fail. The potash from these sources is available now at a cost. Probably our chemists will find new processes which will enable these insoluble sources of potash to equal or better foreign prices.

The reserve supply of phosphate seems to be adequate so far as any reasonable time element is concerned. However, before long it will be necessary to call on the immense deposits of Idaho and other Western states. The problem of transportation will again be before us. We have methods now for rendering the insoluble phosphates of lime available for plant food. They are reasonably efficient in so far as there is little waste of phosphoric acid, but they necessitate the use of an equal quantity of sulphuric acid and a 50 per cent dilution of the product. Here again transportation intervenes. The present freight cost precludes the use of any but the higher grade phosphate rocks. The chemist has before him the problem of rendering the phosphoric acid of these insoluble compounds available for plant food without necessitating the reduction of the plant food content so that excess transportation charges may be overcome. He will, in the near future, be called upon to develop processes for utilizing the lower grade phosphates and phosphatic limestones of Tennessee and Kentucky and even to work over the waste dumps of present-day running.

For a long time it has been considered that these three elements, nitrogen, phosphorus and potassium, were the only plant foods necessary to supply ordinary soil. Recent years have brought about some change in this belief. Certain crops seem to demand some other element that is ordinarily not abundant in all soils. For instance, only within the last few weeks it seems to have been proved definitely that the tobacco plant must have a certain amount of magnesia in its food supply in order that it may properly cure. It is claimed that the superexcellence of the Hawaiian pineapple is due to the manganese present in these soils. Are we then to believe that only these two plants are peculiarly susceptible to such conditions? Can we not safely assume that every plant has a similar necessity? Most of the experiment stations of the country are now studying the effect of sulphur, both elemental and in compounds, on various crops. Oregon has shown surprising results on legumes with sulphates. New Jersey applies elemental sulphur for reaction within the soil itself. What a research field is opened to the agriculturalist and to the chemist!

Balancing Fertility

This further leads us to the question of the balanced ration for plants. We are told that a man at a desk needs so many calories per day, the ditch digger so many more, etc. Our physicians have shown us the effect of a properly balanced diet and the dangers of malnutrition. No doubt plants have the same problems. We can assume that plants properly fed will respond in the same general lines that properly fed animals do. They will be more resistant to attacks of insects and to disease. Furthermore, the main function of the

plants under consideration is to feed man, either directly or indirectly through meat producing animals. A plant not properly nourished cannot be expected to produce as wholesome food as one in perfect condition. A horse that breaks into the corn crib will eat until he founders; a plant offered too much of a single food will undoubtedly have the belly-ache. We hear nowadays a great deal of vitamines and various water or fat soluble unknowns. Truly they are unknowns. We know not what they are, or what produces them, yet they seem to be one of the most important factors in nutrition.

We have determined in a vague way that the biological life of a soil has a great deal to do with the fertility of that soil. We know that certain plants such as legumes will not thrive unless nitrifying bacteria are present. Is it not safe to assume that other plants may be as susceptible to the influence of other bacteria and fungi as are the legume family? Bacteria or other microscopic organisms necessary for one plant may be poisonous to another. We know that certain lower forms of life such as the paramecium abound in the soil and live on bacteria. We know certain bacteria are fatal to certain plants. Undoubtedly crop failures are sometimes due to bacteria and famine enters as a competitor to plague, both from bacteria.

Conclusion

We could go on almost without end pointing out the problems that confront the scientist. These problems must be solved if this country of ours is to maintain itself in the front rank or as the leader of the nations of the world. Our tendency has been recently to commercialize our science. Our agricultural science must be national, must be removed from politics and commercial influences. We must realize that as a nation we must get more from our soil. Our scientists must solve these vital questions in the near future or the coming generations will find their food supply restricted either as to quantity or variety to a point where degeneration of the race sets in and conditions similar to those now obtaining in the Orient will be in effect here.

The Chilean Iodine Industry

Iodine is a most important byproduct of the Chilean nitrate industry. While iodine is recovered from seaweed in Japan (which country relies solely for its requirements upon this source), and also to some extent in France, Scotland, Norway and the United States, by far the greatest quantity of the element is derived from nitrate of soda.

In Chile the iodine industry is controlled by an association known as the Combinacion de Yodo, having its domicile at Iquique, reports Wilfred G. Eyre, clerk in American consulate-general, London, England. This combination at present operates under public deed or contract entered into on April 18, 1894. At a special general meeting held at Iquique on March 28, 1918, this agreement was prolonged to March 31, 1921, and has since been again extended for a further period of three years.

The combination is controlled by a set of bylaws which are of a most comprehensive character, regulating the association in all its spheres of action. The objects of the combination, as set forth in its statutes, are:

(*a*) To regulate the export of iodine.
(b) To regulate the distribution of the quota of each associate in the sales of the combination.
(*c*) To arrange for the sale of the iodine belonging to the associates and for that purpose entering into consignment contracts.
(*d*) To enter into an agreement with producers of iodine in other countries for the sale and supply of the iodine necessary to meet consumption through the instrumentality of agents appointed for that purpose or in any other form which may be found convenient.
(*e*) To bring about in every possible way the consolidation of the combination, procuring the adhesion of new producers and the holders of the stock that later on present themselves; and especially
(*f*) To obtain an increase in the consumption of iodine by means of propaganda, by offering rewards for the best studies suggesting new uses for iodine or to inventors or to those who discover some new application for this article.

Individual members are prohibited from making, exporting, selling, transferring "or otherwise negotiating" iodine, either in Chile or in any foreign country, except as laid down by the bylaws.

Determination of Quotas

Each nitrate establishment belonging to an associate of the combination and actually manufacturing nitrate has the right, even if not equipped for iodine manufacture, to a quota in the monthly sales of iodine. This quota is determined in a manner prescribed in the statutes, each producer having the privilege of selecting either of two methods—(*a*) by actual trial of the establishment's capacity for producing iodine under specified conditions for a period of 90 days, or (*b*) through the decision of experts.

The statutes also give the combination power to enter into a contract for periods not exceeding 5 years with a European firm for the consignment and sale of iodine on the basis of a 5 per cent commission on sales effected by the European agents.

Article 42 of the statutes provides that the associated manufacturers shall pay a contribution not exceeding 5 shillings per quintal of iodine sold to cover the expenses of administration, which will be collected from the associates according to each one's monthly quota. To increase or reduce the contribution requires the assent of 80 per cent of the total membership.

London Sub-Committee

Article 54 provides for the setting up in London of a consultative body known as the iodine sub-committee. Five of the six members of this sub-committee must be persons interested in the nitrate industry and members of the iodine combination or directors or legal representatives of nitrate companies associated in the combination, and the sixth a representative of the consignees.

Any member of the sub-committee who ceases to have the necessary qualifications loses his right to membership.

No two members of the sub-committee can be elected from the the same firm or company.

Physical Properties of Pure Platinum

The chemical division of the Bureau of Standards, in co-operation with the heat and optical divisions, has developed methods of obtaining platinum and some of its alloys in a state of extraordinarily high purity. A very sensitive test for the purity of platinum is afforded by the measurement of its "fundamental coefficient"—that is, the mean change of resistance per degree Centigrade in the interval 0 deg. to 100 deg. C. Some measurements of the fundamental coefficient of this recently produced platinum wire have shown values as high as 0.003922. The highest hitherto recorded value of this coefficient was 0.003917.

Uranium Steels

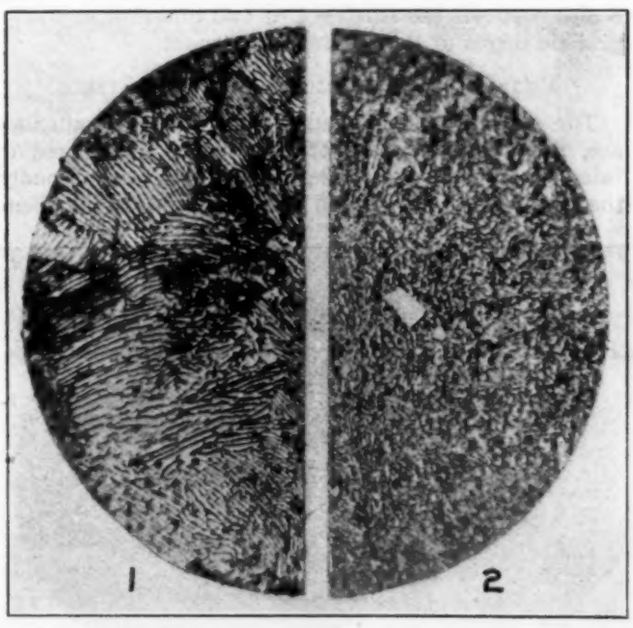
A Discussion of the Microstructure of Steels Containing a Similar Percentage of Carbon and Increasing Percentages of Uranium—Brief Description of the Influence of Uranium as an Alloy in Structural and High-Speed Steels

By HUGH S. FOOTE

IN PEARLITIC ternary steels the special element may exist as (*a*) dissolved in the ferrite, forming with it a solid solution; (*b*) combined with carbon as a double carbide of iron and the special element, or as a mixture of the two carbides; (*c*) partly dissolved in the ferrite and partly combined with the carbon.

Hypo-eutectoid steels containing not more than 0.60 per cent uranium are normally pearlitic, but any increase in the uranium content over this limit produces a characteristic carbidic component which heat-tints in a manner similar to uranium carbide. Fig. 8 shows a eutectic or eutectoid of the carbidic constituent remaining in a steel analyzing C 0.48 per cent and U 4.14 per cent, after being quenched in water from 1,000 deg. C. It is found on analyzing the residue remaining after dissolving annealed pearlitic steels with not more than 0.60 per cent uranium in dilute sulphuric acid with the aid of a galvanic current that the uranium is combined with carbon. At present there is not sufficient evidence to warrant a positive statement in regard to whether the uranium forms a true double carbide or a mixture of the carbides of iron and uranium.

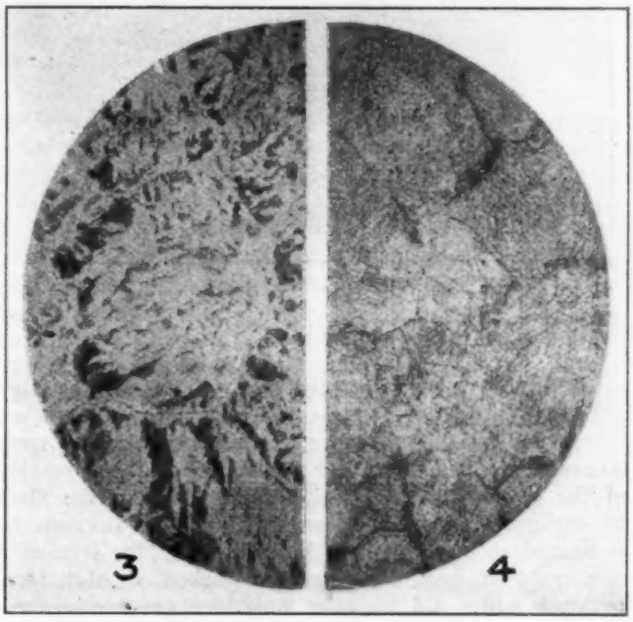
Uranium exerts little, if any, direct influence upon the critical or transformation points of steel up to a content of 2.0 per cent; over this percentage the Ar transformations are lowered and markedly suppressed even at normal rates of cooling. Steels having the lowered transformations are characterized by a martensitic structure, while those having the points suppressed or nearly so exhibit the polyhedral structure of gamma iron and austenite.



FIGS. 1 AND 2. MICROSTRUCTURE OF LOW C:U STEEL. ETCHED IN 5 PER CENT HNO_3 IN ALCOHOL

Fig. 1. Lamellar pearlite in steel (C 0.74, U 0.36) annealed at 1,600 deg. F. and slowly cooled. × 500.

Fig. 2. White double carbide in steel (C 0.63, U 0.40) oil quenched from 1,480 deg. F. and drawn at 480 deg. F. × 1,000.

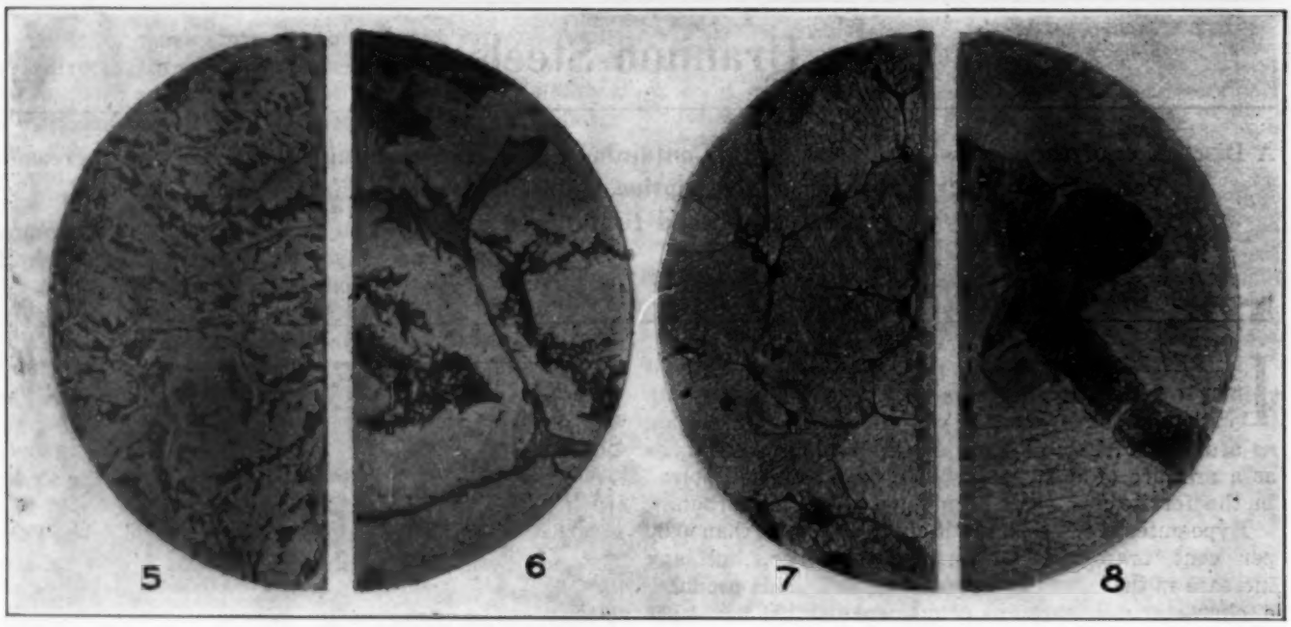


FIGS. 3 AND 4. PEARLITE AND SPECIAL CONSTITUENT IN C 0.31, U 0.86 STEEL. × 150

Fig. 3. Annealed at 1,600 deg. F. Etched with picric acid.

Fig. 4. Quenched in water from 1,830 deg. F. Etched in 1 per cent HCl in alcohol.

The microstructure of pearlitic uranium steels with less than 0.60 per cent uranium shows that they resemble plain carbon steels except that the ferrite-cementite aggregate is finer. Fig. 1 shows a steel with C 0.74 per cent and U 0.36 per cent after annealing at 1,600 deg. F. and slowly cooling to room temperature. With further additions of uranium to about 1.0 per cent the pearlite is no longer lamellar, and a carbidic component is formed. Fig. 3 shows the microstructure of an annealed steel containing C 0.31 per cent and U 0.86 per cent; on quenching the steel is martensitic with the carbidic component rejected to the boundaries of the polyhedral grains. (See Fig. 4.) The microstructure developed by a steel with C 0.48 per cent and U 4.14 per cent, both in the annealed and quenched condition, is illustrated by Figs. 5 to 8. Increasing the uranium, C 0.46 per cent and U 6.97 per cent, produces both on slow cooling and quenching a polyhedral structure containing no traces of martensite; the carbidic component is eutectic in form and is also rejected to the grain boundaries. (See Figs. 9 and 10.) This steel shows also a marked suppression and lowering of the critical points, while an increase in the rate of cooling sup-



FIGS. 5 TO 8. STRUCTURE OF C 0.48, U 4.14 STEEL

Figs. 5 and 6. Annealed at 1,600 deg. F. × 150 and × 1,000 respectively. Etched with picric acid.

Figs. 7 and 8. Water quenched from 1,830 deg. F. × 150 and × 1,200 respectively. Etched with 1 per cent HCl and heat tinted.

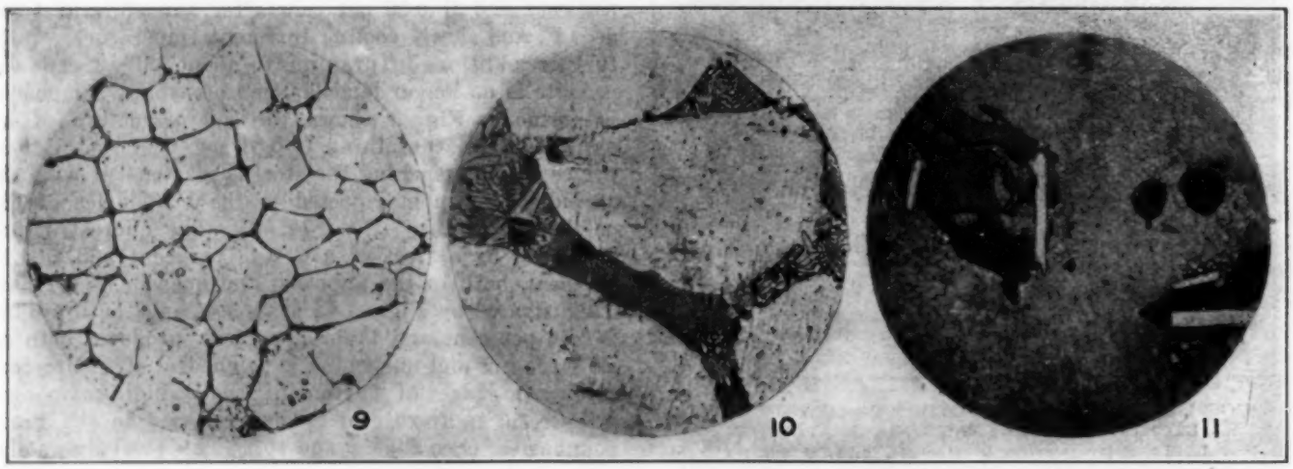
pressed the points entirely and produced the same microstructure as quenching (Fig. 11). Likewise, increasing the temperature from which cooling commenced produced a marked weakening and suppression of the points and the steel became much harder than on cooling from lower temperatures. This may be explained as being due to the solution in the iron of a compound of iron, uranium and carbon at high temperature which did not have time to aggregate on cooling.

Dr. George K. Burgess, of the Bureau of Standards, states that unlike zirconium and titanium, uranium appears to enter into solid solution in steel—that is, it is a true alloying addition. In the normalized specimens a distinct martensitic and troostitic pattern is present, which undoubtedly is due to the presence of uranium in solid solution, as otherwise the structure would be found to consist of granular pearlite and ferrite.

Uranium steels when quenched sometimes contain microscopic white crystals as is shown in Fig. 2. The microscope shows also that (*a*) these crystals do not heat-tint in the same manner as uranium carbide; (*b*) they are not found in annealed steels; (*c*) they are etched only by aqua regia; (*d*) in steels with a uranium content of more than 0.60 per cent uranium where the carbidic component is formed, these crystals are found associated with the carbidic constituent as is shown by Fig. 11. An explanation of the occurrence of these crystals is derived from the analysis of the residue of quenched steels that have been dissolved in dilute acid and aided by a galvanic current; the indications are that a double or complex carbide of iron and uranium is formed at high temperatures which dissociates or dissolves slowly and remains imbedded in the matrix as isolated, microscopic crystals. Examination of Fig. 8 also confirms the existence of two different crystallographic forms of the carbidic component.

Physical Properties of Uranium Steels

The most striking features of uranium as an alloy are, first, that it does not need to be augmented or intensified by the addition of other alloys, and secondly, the readiness with which uranium steels lend them-



FIGS. 9 TO 11. STRUCTURE OF C 0.46, U 6.97 STEEL

Fig. 9. Annealed from 1,700 deg. F. Etched with picric acid. × 70.

Fig. 10. Annealed from 1,700 deg. F. Etched with H_2O_2 and NaOH. × 300.

Fig. 11. Quenched in water from 1,830. Etched in HCl and heat tinted. × 700.

selves to a water-quench. Uranium increases the hardness and hardening power of steels by means of its ability to emphasize the characteristics of the cementite; the hardness imparted thereby is not accompanied by as great a degree of brittleness as that induced by other carbide-forming alloys.

Carbon-uranium steels are pre-eminently adapted for uses which necessitate a low drawing temperature, in that they possess under these conditions a remarkable combination of hardness, strength and ductility. The effect of the addition of small amounts of uranium on the physical properties may be ascertained by an examination of the following tests, made on different classes of steel and compared on a basis of like ductility:

Elastic Limit	Tensile Strength	El. 2 In. Per Cent	Red. Area Per Cent
Carbon 0.32 per cent, uranium 0.22 per cent:			
154,800	162,800	15.5	59.3
Carbon 0.30 per cent, nickel, 3.50 per cent:			
111,000	124,000	15.5	53.0
Carbon 0.30 per cent, chromium 0.95 per cent, vanadium 0.18 per cent:			
146,200	162,700	15.0	57.0
Carbon 0.28 per cent, chromium 0.85 per cent, molybdenum 0.37 per cent:			
154,000	165,000	15.0	58.5

In other words, the addition of a small amount of uranium imparts to steel a sufficient increase in elastic and tensile strengths to make it comparable to the more complex alloy steels.

Small Heats Unreliable

The system of making steels for test or research purposes in an electric furnace of about 400-lb. capacity was abandoned by the writer because of the many defects in the steel. Moreover, the furnace conditions were not easily controlled, with a result that the product was often such as to lead to erroneous conclusions. The test results that follow were made on steels from electric furnace heats of two tons or more each, and the results are representative of each particular type.

TYPE 628

Carbon 0.32 per cent, uranium 0.22 per cent, manganese 0.66 per cent, silicon 0.23 per cent
All bars were quenched in water from 1,550 deg. F.

Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
210,200	230,300	11.0	43.3	444	400
189,400	213,300	12.0	51.0	418	500
180,700	194,100	13.5	52.0	400	600
154,800	162,800	15.5	59.3	350	700
Charpy impact test, 329 ft.-lbs. per sq.in.					700
Alternating impact, 1,556 blows (¼ in. throw.)					700

TYPE 629

Carbon 0.45 per cent, uranium 0.31 per cent, manganese 0.68 per cent, silicon 0.33 per cent.
All bars were quenched in water from 1,500 deg. F.

Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
225,500	250,300	10.5	42.8	522	500
199,900	217,900	12.5	48.1	477	600
171,400	187,900	14.0	54.2	387	700
Charpy impact test, 178 ft.-lb. per sq.in.					700
Alternating impact, 1,200 blows (¼ in. throw).					700

TYPE 630

Carbon 0.54 per cent, uranium 0.29 per cent, manganese 0.61 per cent, silicon 0.28 per cent.
All bars were quenched in water from 1,475 deg. F.

Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
258,300	280,500	8.0	34.0	555	500
227,300	249,500	10.0	40.3	495	600
187,200	205,300	11.0	43.3	394	700
Charpy impact test, 134 ft.-lb. per sq.in.					700
Alternating impact, 850 blows (¼ in. throw.)					700

The tension test-bars were first rough-machined to 2 x 0.550 in., threaded, and after heat-treatment, finished by grinding to 0.505 in. diameter. The influence of heat-treatment on reduced cross-section may be observed by comparing tests made from bars heat-treated at 0.550 in. and 1 in. diameter.

Rough-machined to 0.550 in., then heat-treated and ground to 0.505 in.

Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
194,300	224,800	11.0	39.7	431	400
184,500	206,200	12.0	49.7	418	500
170,000	182,000	12.5	52.7	364	600
150,300	161,600	14.5	54.9	340	700

Heat-treated in 1-in. section, then finished to 0.505 in.

Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
203,800	223,600	10.5	33.4	444	400
185,000	204,300	11.0	37.0	418	500
170,000	188,100	11.5	43.0	375	600
155,300	165,700	13.0	48.0	340	700

Uranium-Nickel Steels

The combination of small amounts of uranium with nickel produces a type of steel in which the desirable features of each alloying element are magnified. The hardness on quenching is increased by the addition of uranium, thus producing a desirable quality in the case of parts that are to be subjected to wear. The effect of additions up to 0.60 per cent of uranium to pearlitic nickel steels is to decrease the grain size and to make the pearlite more sorbitic.

In general, uranium-nickel steels differ from pearlitic nickel steels in these essentials: (*a*) they have higher elastic limits for the same ductility; (*b*) they are harder than nickel steels when heat-treated; (*c*) they are more susceptible to heat-treatment—uranium-nickel steels harden considerably when cooled in air; (*d*) they possess superior dynamic toughness and resistance to fatigue when properly heat-treated.

TYPE 638

Carbon 0.28 per cent, uranium 0.35 per cent, manganese 0.49 per cent, silicon 0.16 per cent, nickel 1.25 per cent
All bars were quenched in water from 1,550 deg. F.

Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp Deg. F.
196,200	226,200	10.5	38.1	418	400
192,000	209,100	12.0	47.4	418	500
175,000	186,300	12.5	48.6	364	600
155,500	162,800	13.0	50.3	311	700

TYPE 517 (MADE IN 35-TON ACID OPEN-HEARTH)

Carbon 0.39 per cent, uranium 0.22 per cent, manganese 0.60 per cent, silicon 0.20 per cent, nickel 3.00 per cent
All bars were quenched in oil from 1,425 deg. F.

Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
206,400	248,600	13.0	47.7	512	400
199,200	231,600	13.5	51.1	477	500
183,300	202,100	13.5	54.1	418	600
164,100	177,200	15.0	56.0	387	700
Charpy impact test, 156 ft.-lb. per sq.in.					700
Alternating impact, 934 blows (¼ in. throw.)					700

TYPE 178 (MADE IN 6-TON ELECTRIC FURNACE)

Carbon 0.45 per cent, uranium 0.29 per cent, manganese 0.48 per cent, silicon 0.53 per cent, nickel 3.00 per cent.
All bars were quenched in oil from 1,475 deg. F.

Elas. limit.	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
244,500	290,100	10.0	29.1	555	400
238,900	271,100	10.5	35.5	512	500
212,000	228,000	11.0	39.0	464	600
185,500	198,200	12.0	45.0	415	700
Charpy impact test, 73.8 ft.-lb. per sq.in.					500
Alternating impact, 900 blows (¼ in. throw.)					500

Uranium High-Speed Steels

A metallographic study of uranium high-speed steels indicates that the uranium tends to promote the formation of complex carbides. The cutting efficiency and the property of "red hardness" of high-speed steels is wholly dependent upon complex carbides. According to Osmond, when steels of this type are heated to a high temperature, the carbides dissolve and change the composition of the gamma iron solid solution, by means of which the critical points are lowered. In other words, it is the increased amount of dissolved carbides which causes the end of the transformation to fall below ordinary temperatures, with the result of partial aus-

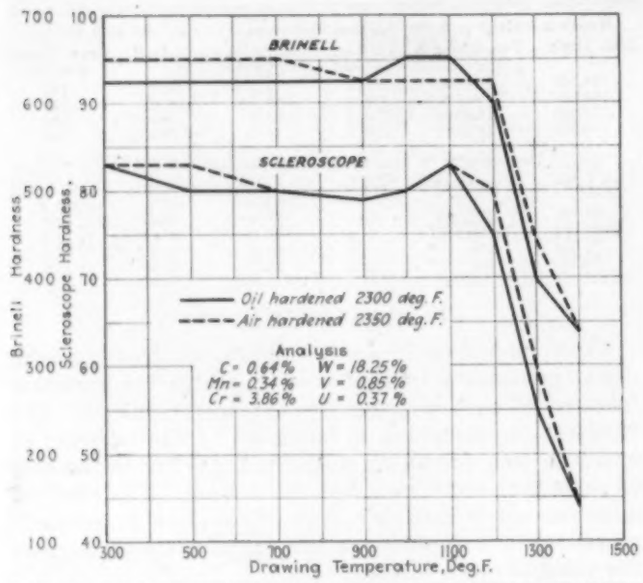


FIG. 12. VARIATION IN HARDNESS OF URANIUM-BEARING HIGH-SPEED STEEL AS DRAWING TEMPERATURE CHANGES

tenitization. The "secondary hardening" is due to the fact that when the partly austenitic steel is tempered, the dissolved carbides are slowly precipitated to a stage where the transformation is completed and the steel is martensitic. According to Scott,[1] the microscopic evidence is positive that the constituent which accompanies the appearance of "secondary hardening" is martensite.

A comparison between the microstructures of a uranium and a uranium-free high-speed steel annealed at the same temperature shows that steels containing uranium show in general a larger number of carbide globules than are found in uranium-free steels; in the

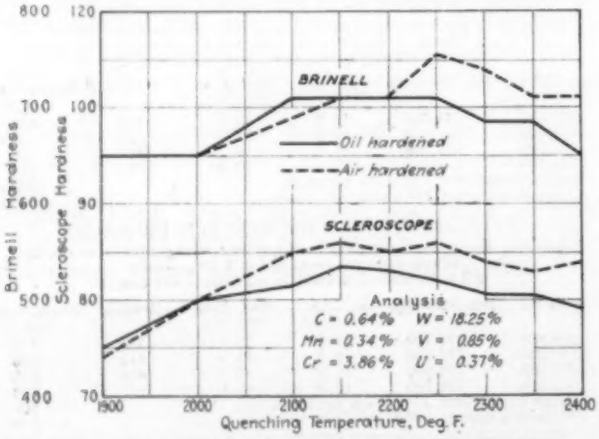


FIG. 13. VARIATION IN HARDNESS OF URANIUM-BEARING HIGH-SPEED STEEL AS QUENCHING TEMPERATURE CHANGES

hardened condition, both classes show practically the same amount of undissolved carbides. Since the complex uranium-carbide is apparently more soluble in gamma iron than those complex carbides ordinarily found in high-speed steels, it is reasonable to infer that uranium exerts an important influence on the property of "secondary hardness."

Curves are shown in Figs. 12 and 13 to illustrate the effect of different quenching and drawing temperatures on a uranium high-speed steel.

[1]Howard Scott, Bureau of Standards Scientific Paper 359.

Method for Obtaining Color Value of Sugar Solutions

Many sugar solutions, such as molasses, contain so much coloring material that they are too dark to be read on color-measuring instruments even when the thickness of the layer used is decreased as much as is practicable. Dilution of such heavy, dark-colored solutions with water causes some change to take place, resulting in a flocculation and precipitation of a part of the coloring material which is present in the undiluted solution. This precipitated material is so fine that it does not settle and therefore renders the solution turbid. If this turbid solution is used to determine the color value of the original dark-colored solution, an error is caused by the dispersion or scattering of the light by the fine precipitated particles. If these particles, which are known scientifically as dispersoids, are filtered off and the remaining clear liquid used, an error is likewise made, since a part of the coloring matter which was originally present has now been removed.

A new method for the measurement of the color value of sugar solutions is being developed by the United States Bureau of Standards in which these errors are avoided. The method consists essentially in diluting the dark-colored solution in a concentrated sugar sirup of known color value. The dilution with water decreases the protective influence of sucrose, which acts as a protective colloid, while the dilution with concentrated granulated sirup maintains the same state of equilibrium and prevents the precipitation of the coloring material. Beer's law is valid only as long as flocculation and change in color value are prevented. If laboratory practice invalidates the law, truthful results cannot be obtained. This fact has been ignored by technical sugar chemists up to the present time. The basic principles of technical colorimetry stated by Stammer, long before the days of colloidal chemistry, have never been tested under more modern conditions.

Production of Asphalt Increases

The quantity of native asphalt and native bitumens sold in the United States in 1920 was 198,497 short tons, valued at $1,213,908, according to the United States Geological Survey. This was an increase of 125 per cent in quantity and of about 78 per cent in value over 1919. Gilsonite was reported from Uinta County, Utah, wurtzilite (or elaterite) from Duchesne County, Utah, and grahamite from Pushmataha County, Okla.

The sales of manufactured asphalt obtained from domestic petroleum amounted to 700,496 short tons, valued at $11,985,457, or $17.11 a ton. Compared with 1919 these figures indicate an increase of 14 per cent in quantity and 37 per cent in value.

The sales of asphalt manufactured in the United States from Mexican petroleum in 1920 amounted to 1,045,779 short tons, valued at $14,272,862, or $13.65 a ton. This was an increase of 55 per cent in quantity and of 85 per cent in value over 1919.

Coal Production in France's Devastated Region

Considerable progress was made in the exploitation of the war-damaged coal mines of France during the first half of 1921. Altogether the mines in the Departments of the North and the Pas-de-Calais produced 7,344,000 tons of coal during the first six months of 1921, as against 3,534,000 tons in 1920. During the first half of 1913 they produced 14,946,000 tons.

Air Required in Baking Cores Made With Linseed Oil

Results of Laboratory and Plant Experiments on the Consumption of Air and Oxygen in Baking Linseed Oil-Bound Cores, Together With a Review of Available Data on the Absorption of Oxygen by Linseed Oil in Drying

BY A. A. GRUBB AND U. S. JAMISON*

THE ventilation of an electric core oven is a problem quite different from that of an oven using coal, coke, oil or gas as its source of heat. In the latter case the hot gases from the burning fuel are permitted to pass over the cores; these gases contain a large percentage of uncombined oxygen, so there is always present a great excess of oxygen over any quantity actually required in the baking process. The ventilation required to maintain proper combustion is always sufficient, too, to carry out of the oven any water vapor and other gases which may be formed.

But not so with the electric oven. No ventilation is required for operation of the heating elements, so any air passed through the oven is for the sole purpose of supplying oxygen and carrying off gases; further ventilation results only in loss of expensive heat energy.

Linseed oil differs from water-soluble binders in that its hardening in the core in the process of baking depends upon oxidation rather than merely losing moisture. Water is used in green core sand along with oil to improve the green bond properties and permit the sand to be packed closely enough that the oil can cement contact points together. In sands containing clay or other natural bond the water also serves to form a sort of plaster or semi-solution of this bonding material so that upon drying the grains of sand are cemented together.

The quantity of air which should be supplied to the baking cores is determined, then, by two factors: first, the moisture coming off the cores must be diluted or carried out of the oven, and second, sufficient oxygen must be supplied to oxidize the oil properly. It may be necessary to supply an excess of oxygen over that actually used; if so, how great an excess?

MOISTURE ELIMINATION

Green core sand contains on an average about 6 per cent of moisture. This is nearly all in the vapor form before the bake is half completed. A series of temperature readings made by means of a thermocouple point located in the center of a baking core show that the rise in temperature is retarded somewhat in the neighborhood of 212 deg. F., after which it again continues to rise at its former rate, indicating that the water has been vaporized. Each 100 lb. of green core sand contains about 6 lb. of water, which upon vaporizing expands to about 165 cu.ft. at 212 deg. F. and to still greater volumes at higher temperatures. The steam would thus drive practically all the air from the oven or at least dilute it to an extent that there would be insufficient oxygen for the bake were it not for the admission of fresh air through ventilating ports or openings about the doors. These considerations point to the necessity of introducing some air into the oven in order to carry out the water vapor. Inasmuch as practically all the oxidation occurs during the latter half of the bake, the need for air is not imperative until after all the water has been vaporized and the temperature has risen pretty well toward maximum.

OXIDATION OF LINSEED OIL

Upon exposure to the air linseed oil absorbs oxygen and is converted into a tough or even hard varnish. Ordinarily this transformation is very slow, but it may be hastened by raising the temperature 300 or 400 deg.; higher temperatures are apt to cause at least partial decomposition.

According to Cloez[1] fresh linseed oil is composed as follows:

	Per Cent
Carbon	77.57
Hydrogen	11.33
Oxygen	11.10

When thoroughly dried he found that 100 g. of this oil had increased to 107 g. as follows:

	G.
Carbon	72.27
Hydrogen	10.57
Oxygen	24.16
Total	107.00

These figures indicate that in drying 100 g. of linseed oil, 5.3 g. of carbon and 0.76 g. of hydrogen are given off. Possibly these were given off in part as hydrocarbons, but it is more probable that they were oxidized to carbon dioxide and water. The figures also show that 13.06 g. of oxygen were absorbed and retained. If we assume that the carbon and hydrogen which were lost were oxidized to carbon dioxide and water, then the 5.3 g. of carbon would unite with 14.1 g. of oxygen to form 19.4 g. of carbon dioxide, and the 0.76 g. of hydrogen would unite with 6.08 g. of oxygen to form 6 84 g. of water. The complete drying of 100 g. of linseed oil would then require 33.24 g. of oxygen and would produce 19.4 g. of carbon dioxide. A. Genthe,[2] another investigator, found that in drying, linseed oil absorbed 23 per cent of oxygen. The work of these investigators, then, indicates that between 30 and 40 g. of oxygen is required to completely dry 100 g. of fresh linseed oil.

LABORATORY TESTS

A number of experiments were made to determine the quantity of air which should be supplied and the quantity of oxygen actually used in thoroughly baking linseed oil cores. A Vitrosil tube, 1 in. in diameter and 12 in. long with a 4-in. transparent section in the middle, was set up horizontally in such manner that it could be heated with bunsen burners. In the ends of

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[1] Allen's Commercial Organic Analysis, vol. 2, p. 345.
[2] *Ibid.*, vol. 2, p. 348.

the tube were placed rubber stoppers, one of which supported a thermometer so set that it showed the temperature in the middle of the tube. Air entering the tube was passed through a calcium chloride tube to insure dryness. Upon leaving at the other end of the vitrosil tube, the gases were drawn through another calcium chloride tube and a soda lime and caustic tube for carbon dioxide absorption. A calibrated water-bottle aspirator was used for drawing air through the train. The air which was received in the water bottle was analyzed for oxygen content by means of an Orsat gas apparatus. The difference between this value and 20.8 was taken as a measure of the oxygen used in baking the core.

The core sand used in the tests was one of the standard mixtures used in our core room. It consisted of 70 volumes of Michigan City lake sand, 30 volumes of sand-blast dust, 8 volumes of water and 2 volumes of raw linseed oil. According to weight such a mixture is 5.05 per cent water and 1.18 per cent linseed oil. The sand, water and oil were measured out accurately and mixed in a glass-stoppered salt bottle to prevent evaporation. The cores were made and baked in 3-in. nickel combustion boats. The boats were filled with green core sand, firmly pressed down and then stroked off even with the edges. This produced cores of uniform size. All the test-cores were baked for 45 minutes. When baked they were allowed to cool in a desiccator and were then tested for strength by resting them on two knife edge supports 1¾ in. apart and applying weight midway between the supports. Breaking strengths of less than 450 g. indicate cores that would be unsatisfactory for general foundry work on account of their fragility, while results over 600 g. indicate very strong substantial cores.

TABLE I. LABORATORY TESTS ON OIL-BOUND CORES

No.	Wt. of Green Core, G.	Loss in Weight, G.	Water, G.	Carbon Dioxide, G.	*Air Used, C.c.	Oxygen Used, C.c.	O Used per G. of Oil, G.	Temp. Range, Deg. F.	Mean Temp., Deg. F.	Breaking Strength, G.
1	8.371	0.420	0.113	0.140	767 1,000	115	1.55	475–530	500	127
2	8.524	0.431	0.094	0.107	656 990	108	1.43	440–540	500	257
3	8.339	0.413	0.306	0.042	656	82	1.11	470–520	478	326
4	8.431	0.402	0.372	0.030	648	74	0.99	348–360	452	523
5	8.314	0.420	0.210	0.034	664	69	0.94	418–432	422	612
6	8.491	0.391	0.361	0.028	633	68	0.90	420–442	422	523
7	8.342	0.451	0.224	0.031	651	66	0.89	420–440	425	457
8	8.378	0.408	0.106	0.053	620 1,070	65	0.87	380–410	400	585
9	8.196	0.392	0.169	0.018	648	52	0.71	361–378	365	775
10	8.529	0.380	0.175	0.018	676	49	0.65	368–388	377	672
11	8.535	0.431	0.307	0.010	633	35	0.47	350–374	360	613
12	8.375	0.390	0.289	0.021	620	32	0.43	358–384	370	590
13	8.915	0.346	0.056	0.013	892 1,160	34	0.43	300–335	315	359
14	8.934	0.408	0.428	0.007	199 672	31	0.39	380–398	390	588
15	8.287	0.343	0.074	0.018	787 1,070	29	0.39	280–320	300	466
16	8.776	0.411	0.411	0.012	115 642	24	0.31	380–398	389	265
17	8.681	0.381	.....	0.006	622	24	0.31	338–342	340	133
18	8.861	0.401	0.435	0.010	122 650	23	0.29	380–404	391	329

* When two numbers for "Air Used" are given in the table, the upper one indicates the number of cc. air admitted or passed over the core while it was baking.

The accompanying table shows the results of eighteen tests, together with some of the calculated results. They are arranged in order according to the quantity of oxygen absorbed per gram of linseed oil in the core. In several of the experiments the tube was cooled as soon as the bake was complete and more air was then passed through to sweep the tube. The second number gives this total volume which was sampled for the oxygen determination. In addition to the tests recorded in the table, two cores were baked in an atmosphere of carbon dioxide; they were of a grayish color and so weak that they could scarcely be supported on the fingers. Four cores were also baked in a large excess of air, the ends of the Vitrosil tube being left partly open; the average baking temperature was 393 deg. F. and the average breaking strength was 612 g.

Discussion

While the results were not as uniform as might be desired, we believe they were as nearly so as could be expected from this sort of problem and this method of handling it. A survey of the figures shows the following points worthy of notice:

1. The nine strongest cores—Nos. 4, 5, 6, 8, 9, 10, 11, 12 and 14—were baked at an average temperature of 395 deg. F. They used 0.73 g. of oxygen per g. of linseed oil and broke under an average load of 609 g.

2. Nos. 1, 2 and 3 were baked at too high temperatures; the average was 493 deg. F. They used 1.36 g. of oxygen per g. of oil and broke under a load of 237 g.

3. Nos. 13, 15 and 17 were baked at too low temperatures; the average was 318 deg. F. They used only 0.38 g. of oxygen per g. of oil and broke under a load of 319 g.

4. Nos. 16 and 18 were baked at the proper temperature, but insufficient air and oxygen were supplied; the average baking temperature was 390 deg. F. They used only 0.30 g. of oxygen per g. of oil and broke under a load 297 g. Practically all the oxygen admitted to the cores was used.

5. Considering the nine strongest cores mentioned above, 5,341 c.c. of air supplied the oxygen for baking 76.2 g. of green core sand; this was in the ratio of 8.5 lb., or 112 cu.ft., of air at room temperature to each 100 lb. of core sand. Oxygen to the amount of 475 c.c. was absorbed; this was about 40 per cent of oxygen content of the air supplied to the cores.

6. No. 14 used 75 per cent of the oxygen supplied to it and produced a fairly strong core.

Plant Tests

An attempt was made to check the above results by tests in an electric core oven in our foundry core room. This oven had a volume of 350 cu.ft. and was equipped with a fan and ventilating device so arranged that the air in the oven could be recirculated or fresh air could be introduced from without, part of the exhaust passing up the flue. When the fan was operated, it was set to recirculate entirely or else to recirculate and introduce fresh air at the rate of about 300 cu.ft. per minute. This figure was determined by placing a Pitot tube draft gage in the exhaust flue. The temperature of the oven was controlled by a thermostat. Five bakes were made, varying the quantity of air introduced. In addition to the regular cores, twelve test briquets, similar in shape to those used in cement testing, were placed on each rack. The test-cores were made of the same mixture as the laboratory test. After baking, they were broken on a Wadsworth core-testing machine; a breaking strength of 40 lb. indicates a fair core, above

TABLE II. TESTS ON LARGE CORE OVEN

	Wt. of Cores, Lb.	Time in Oven, Min.	Fan Recirculating, Min.	Fan Exhausting Min.	Air Admitted to Cores, Lb.	Average Strength, Lb.
1	300	68	12	3	85	55
2	287	65	12	1	40	61
3	320	70	15	0	17	54
4	312	78	0	0	17	52
5	337	70	0	1	40	53

60 lb. a very strong one. Table II gives a summary of the results obtained.

In each case except No. 4 the fan was operated near the middle of the bake. This was done in order to clear the oven of water vapor and other gases. In No. 1 the fan exhausted for 1 minute about a quarter of an hour before the rack was removed. The figures on "Air Admitted to Cores" were calculated from the period the fan was exhausting and drawing in air, and the estimated air content of the oven was added in; hence these figures are very approximate.

Oxygen determinations were made on samples of air drawn from the oven during the latter part of bakes Nos. 1, 4 and 5. No. 1 gave values of 19.8 per cent and 18.0 per cent. No. 4 gave 11.3 per cent and 13.0 per cent. No. 5 gave 16.7 per cent, 14.1 per cent and 15.0 per cent.

Discussion

The test-cores differed but little in strength—all were good. Evidently we were unable to cut down the air supply to a point where the strength of the cores was seriously affected. Ventilation served possibly to reduce the time of bake, but even in No. 4, with no fan ventilation, there was sufficient air in the oven or enough leaked in around the doors to produce good cores. According to the laboratory test, 300 lb. of cores should require about 2.5 lb. of oxygen. However, 17 lb. of fresh air contains only 3.9 lb. of oxygen, so either the "Air Admitted" figures given in the table are too low or the oxygen determinations are too high. It is very likely that more air than that recorded got into the oven, as there were rather loose fitting doors at both front and rear. Even when making allowance for these possible errors, it is evident that from 8 to 10 lb. of air, possibly less, supplies sufficient oxygen to bake properly 100 lb. of green core sand.

Conclusions

In order to bake linseed oil-bound cores properly, at least 1 lb. of oxygen should be supplied for each pound of linseed oil in the cores. This would require about 4.5 lb., or 60 cu.ft., of fresh air. Each 100 lb. of green cores should then have at least 5 lb., or 67 cu.ft., of air. These figures indicate only the minimum quantity required for oxidation purposes. It is well to change the air in an oven at least once after the moisture has been vaporized. Where fuel is cheap, greater excesses of air probably have no harmful effect and may be of advantage.

In the correct bake linseed oil uses about 0.73 per cent of its weight of oxygen. This figure is considerably higher than those given by Cloez and Genthe, referred to above, for oxygen used in drying linseed oil. We need not be surprised at this, because a properly baked core is more than dried. We have found in our core room that a linseed oil core shows a slight greenish tinge when merely dried out. When a brass casting is poured about such a core, a "core blow" is very apt to result and the core, instead of becoming very fragile and easy to remove, bakes hard in the casting. On the other hand, when baked to a decided brownish color, they can usually be knocked out of the castings without trouble.

These facts indicate that in core baking the oxidation process is carried beyond the drying stage; the oil is actually burned in a slight degree.

Mansfield, Ohio.

Legal Notes

By Wellington Gustin

The Conrad Patents, the Noiseless Gear Using Bakelite Micarta, Void for Lack of Invention

The Conrad patents, No. 1,167,742 and No. 1,167,743 for a noiseless gear, the material of which is a composition of bakelite and fiber, known as "Bakelite Micarta," of which Conrad was not the inventor, have been held void for lack of invention in the United States District Court, Southern District of Ohio, by Judge Peck. (Westinghouse Electric & Manufacturing Co. vs. Fornica Insulating Co., 270 Fed., 632.)

The complainant sought to enjoin defendant from the manufacture and sale of blanks to be used in the making of gear wheels composed of a fibrous material with a phenolic condensation product for a binder, which was charged to be a contributory infringement of said Conrad patents as owned by it. The defense was that the patents were void for want of invention, or, if showing invention, because Conrad was not in fact the first inventor, and for want of novelty.

Description of the Patent in Dispute

The subject-matter of the patent was the non-metallic or noiseless gear. The object sought by the inventor was the production of a gear wheel which would be light, strong, durable, infusible and impervious to moisture and to most chemicals. To obtain this result, said the court, sheets of fibrous material, such as cloth or paper, are impregnated with an adhesive liquid material, preferably a phenolic condensation product, such as bakelite dried in an oven, laid together with the treated side of one to the untreated side of the next, hydraulically pressed under heat until the material is fully impregnated and firmly cemented into a hard, compact mass, and, after cooling, subjected to a baking process. The result obtained is a laminated fibrous material, capable of withstanding great heat, of high tensile strength, which can be turned and bored in the same manner as wood. The finished plates are then cut into gears in the usual way. As a modification metallic end plates or shrouds were placed on gears to protect the edges of the composite structure from injury and to give added strength.

The binding material, bakelite, is described as a condensation product of phenols and formaldehyde. Claim 7, which is typical of those relied on, states: "A gear having a self-sustaining working body portion, composed of fibrous material and a phenolic condensation product."

The complainant produced by the process a gear which was highly useful and commercially successful, but also superior in some adaptations to all preceding types of noiseless gears. The question presented to the court was, How much of this result can be attributed to the exercise of the inventive faculty of Conrad?

Gears Described in Baekeland Patent

The new element that made this success possible was a composition of bakelite and fiber, together known as "Bakelite Micarta." This material was admitted to be the production of Dr. L. H. Baekeland, covered by his patent No. 941,605. It is said that the same process of

building up the laminated material described in Conrad's patents is fully set forth by Dr. Baekeland in his composite cardboard patent of March 5, 1912, No. 1,019,406. On Dec. 16, 1910, Dr. Baekeland filed his application for a patent on a "machine element," meaning thereby gears, pulleys, etc. This application, filed 2½ years before that of Conrad, although not allowed until after Conrad's application had been filed, was considered in determining the question whether Conrad was the first inventor under the patents in suit. Baekeland described a gear made of a phenolic condensation product, either compounded with fiber, or built up with layers of wood, cardboard, paper, or similar porous material, and compressed between metal plates. This was to be done either with or without the use of interior metal strengthening plates. The gears were then to be cut from disks of the material so formed. He described such gears as capable of withstanding comparatively high temperature and of enduring conditions destructive to most plastic compositions, as being of great hardness, toughness and wearing qualities, and, as against metal gears, silent in operation. The difference between the two patents appears that in Baekeland the reinforcing plates are considered essential to the strength of the gear, while in Conrad they were considered optional with the gear maker.

Was Conrad's Advance Patentable, Asks the Court

Conrad knew the material as suitable for gears without reinforcement as well as with it. Baekeland's material was bakelite, fiber and metal; Conrad's was bakelite and fiber, with or without metal, as conditions might warrant. Conrad's advance was that the supporting metallic plates might, in cases, be omitted. Was this invention in a patentable sense, the court asks.

Baekelite Micarta is described as a hard, fibrous substance, strong, insoluble, infusible and resistant to water, oil and most chemicals. It was at the time of the application for patents in suit used mostly as an electric insulating material. Noiseless gears of rawhide, compressed fiber, or fabroil, and vulcanized or hard fiber were common. Rawhide and fabroil were compressed and held in shape by end plates. Hard fiber, on the other hand, was a self-sustaining material. It was composed of cotton-rag paper treated with chloride of zinc, which rendered it gelatinous and adhesive. The layers of material, having been so treated, were pressed together and formed a laminated, fibrous, self-sustaining, hard material, useful for gear making. The resemblance of Bakelite Micarta, the new material, to the hard fiber was striking. The difference was that the Micarta contained a new and better binding cement, and the process of its manufacture was not injurious to the fiber and left it unimpaired. The question arises, Was it after all anything more than an improved hard fiber?

Then if hard fiber had been familiarly utilized for the manufacture of noiseless gears for years, was it a patentable invention for Conrad to employ the greatly improved hard fiber, Micarta, which itself was not his invention, for the same purpose? The answer to this question determined the matter for the court.

The old hard fiber gears had been used with and without end plates and shrouds. Conrad described in his patent a gear made of Micarta without such supports, but did so as an alternative. In his claim he is careful to limit the use of the material to the "working body portion," thus covering a gear supported by end plates, they not being the working body portion thereof. Therefore the court held that Conrad's effort was but the skillful selection of material rather than invention, and that both his patents were void.

Substitution of one material for another, which does not involve change of method nor develop novelty of use, even though it may result in a superior article, is not necessarily a patentable invention, says the court.

The bakelite gear was held to be an infringement of the compressed fiber or fabroil gear in the case of General Electric Co. vs. Continental Fiber Co., which the reader may find in vol. 256 of the *Federal Reporter*. It was here held by the Circuit Court of Appeals that the Miller patent for the use of compressed textile fabrics for gear manufacturing was fundamentally new and entitled to a broad range of equivalents. Its infringement was based on the ground that both depend upon the presence of a large number of fibers in a small space.

Condition in Offer Prevents Contract Agreement

In an action by the Atlantic Terra Cotta Co. against the Chesapeake Terra Cotta Co. (113 Atlantic, 156) plaintiff sought to recover damages for the wrongful repudiation of an alleged contract to accept and use certain terra cotta. A memorandum of the alleged agreement was made in writing and signed by both parties. The first condition of plaintiff's proposal was as follows: "(1) This proposal is good for thirty days from date, and acceptance thereof is subject to a form of contract satisfactory to us."

Now the court said that had this proposal been omitted from the written offer made by the plaintiff, the written acceptance of the defendant could have been held to constitute a valid contract, upon the ground that although neither the offer nor the acceptance contained any express intent as to the time of delivery or payment, yet in such case the absence of the ordinary stipulations as to time of delivery and time of payment would be supplied by implication of law. Where no time for delivery is fixed by such a contract, the law implies delivery within a reasonable time. Where no time of payment is fixed by such a contract, the law implies that the time of payment is upon the delivery of the goods.

Written Condition Was One Precedent to Contract

The essential question, therefore, was whether this cited condition was one precedent to the formation of a contract between the parties in reference to the offer that a formal written contract should be executed, and whether writing upon the offer that it was accepted did create a contract.

The Supreme Court of Errors of Connecticut in the case affirmed the judgment of the trial court that such acceptance of the offer did not create a binding contract, but said the completing of a contract depended upon later extension of a formal contract.

Further, this court says: "Where there is no written proposal or acceptance expressed to be subject to a formal contract, but there has been a reference to a written contract in the negotiations, then it becomes a question of fact whether the parties intended the agreement in a certain memorandum to constitute a contract or intended that there should be no contract until the execution of a formal written contract; and such intention is to be gathered from the language used when interpreted in the light of the attendant circumstances."

Non-Magnetic, Flame-, Acid- and Rust-Resisting Steel

New High Alloy Steels Developed in the Research Laboratory of the Crucible Steel Co. Which Can Easily Be Worked and Machined, but After Heat-Treatment Become Hard and Resistant to Attack of All Agencies

A SHORT NOTE on a "Highly Resistant Alloy Steel" appeared in CHEMICAL & METALLURGICAL ENGINEERING for Sept. 22, 1920 (vol. 23, p. 568), following the presentation of a paper on this subject before the American Society for Steel Treating, by Charles M. Johnson, director of research department, Crucible Steel Co. of America. This paper has been printed in full in the July 1, 1921, issue of that society's *Transactions.*

Several of these high-alloy steels were studied primarily in an effort to find a steel which could be forged, rolled or sheared in thicknesses down to 0.01 in., be machinable in the cold, yet offer maximum resistance to cutting flames. It was found that polished samples of sheet made from the experimental melts, when immersed twenty-four hours in various solutions, showed remarkable resistance to acid solution, as indicated in Table I.

These steels have therefore been called "Rezistal," and a certain amount of them placed on the market. When attacked by an oxyacetylene flame it takes twenty times as long to melt a hole through it as does ordinary steel. Exposed to oxidizing flame Rezistal is only slightly stained after several hours in a gas furnace at 1,100 deg. C. (2,000 deg. F.), indicating its utility for racks, clamps and other heat-treating fixtures. Tests for thirty minutes at 1,100 deg. C. are also included in Table I, + measuring gain in weight, — loss. Copper solutions, which plate out readily on high-chromium steel, will not deposit copper on grades 3 and 4. Rezistal will remain for days in Pittsburgh tap water, developing only the faintest traces of rust; it resists saturated H_2CO_3 even better. Paring knives from grade 2 will not stain in fruit juices, but furthermore do not stain the operators' fingers if the handles are made of wood or fiber.

Further tests by corroding agents follow:

Lead. A 1,200-g. crucible of No. 3 gained 0.43 g. after holding lead eight hours at 900 deg. C. (1,650 deg. F.). No scaling occurred on the outside.

Cyanide. Metallic samples were immersed one hour in NaCN at 1,000 deg. C. (1,850 deg. F.). Grade 3 lost 154 mg. per sq.in.; copper steel 482; wrought iron 478.

Concentrated Salt Solution. Slight tarnish after seventy-two hours.

Pasty Quick Lime. No change after 170 hours.

Neat Cement. No change after twenty-two days.

Concentrated Carbolic Acid. Trace of discoloration after ninety-two hours.

Oxalic Acid. Lost 1.41 mg. per sq.in. in ninety hours.

Hot Asphaltum. Slight discoloration suggesting an enamel after one hour.

Silver Nitrate. No effect, cold or hot.

Saturated Alum Solution. Slightly etched in spots after twenty-two hours.

Caustic Soda. No effect after three hours' boiling in 20 per cent solution.

Rancid Butter. No effect after eight days.

Sulphurous Acid. Quickly assumes dark protective coating, after which loses 0.3 mg. per sq.in. per day.

Mercuric Chloride. Bright and lustrous after 120 hours in cold (loss 0.45 mg. per sq.in.) or thirty minutes in boiling N/1000 solution (loss 2.1 mg.).

Lactic Acid. No effect after twenty-four hours in 0.2 or 1.0 per cent solution; loss in latter case 0.1 mg. per sq.in.

Gasolene. Slight brown tarnish after thirty days; loss 0.63 mg. per sq.in.

MAGNETIC PROPERTIES

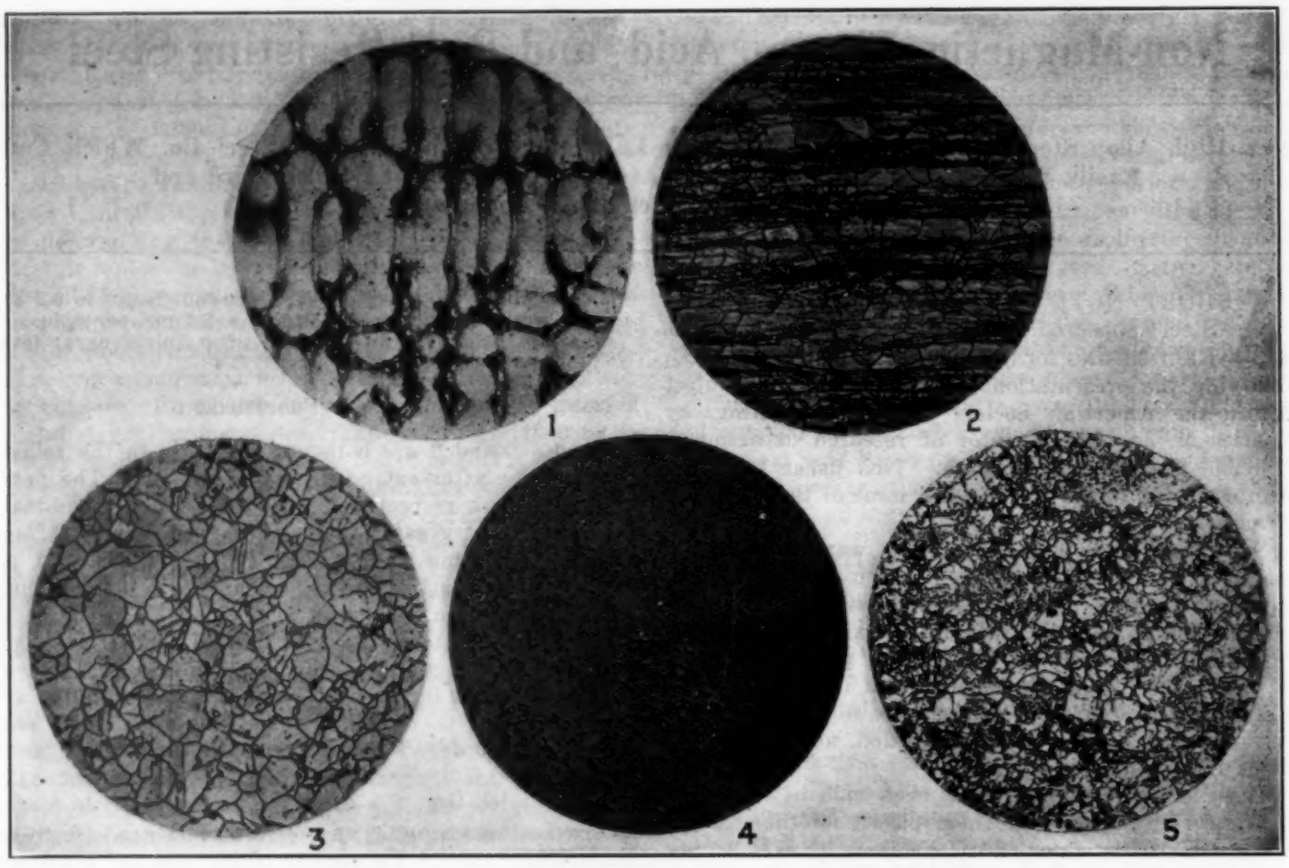
Grades 2 and 3 are both non-magnetic in the rolled condition or after extended heat-treatments. The permeability with respect to air is 1.05, and the residual magnetism not greater than 4 lines per sq.cm. After prolonged heating at 700 deg. C. (1,300 deg. F.) a slightly greater attraction to a magnet was noticed, but this was lost by a short heat to 870 deg. C. (1,600 deg. F.). It is of interest to note in this connection that high-carbon manganese steel of the Hadfield type shows a similar slight increase of magnetic susceptibility at about 650 deg. C. (1,200 deg. F.), but more so at 595 deg. C. (1,100 deg. F.) after ten minutes' heating and also loses this increased susceptibility at about 815 deg. C. (1,100 deg. F.) after ten minutes. Cold work increases the magnetic susceptibility of grade 3 to a noticeable extent. To remove this, heat to 1,000 to 1,100 deg. C. (1,950 deg. F.) for a few minutes; cool in air and heat again if necessary.

Three grades of Rezistal were immersed in boiling liquid air for ten minutes together with a piece of ordinary sheet steel and a piece of 25 per cent nickel steel. The 25 per cent nickel steel showed strong magnetic susceptibility (about the same as ordinary steel), but after removing it from the boiling air this effect was entirely gone in one minute. The three grades of Rezistal were not attracted by the magnet immediately after removing from the liquid air or when still immersed.

It was also found that while the ordinary sheet steel on being taken out of the liquid air was very brittle and could be snapped off with a pair of pliers, the new alloys and also 25 per cent nickel steel were apparently as tough as ever, showing no indication of brittleness. Therefore Rezistal can be described as tough and strong in all temperatures from — 185 to + 1,300 deg. C.,

TABLE I. CORROSION TESTS. LOSS IN MG. PER SQ.IN.

	Glacial Acetic	32 per Cent H_2SO_4	10 per Cent H_2SO_4	32 per Cent HNO_3	19 per Cent HCl	Cold Concentrated HNO_3	Water Saturated With Oxygen	Oxidising Atmosphere at 1,100 deg. C.
Grade 5-2	....	2.0	....	....	....	....	0.00	.....
Grade 4-2	6.15	3.3	3.2	0.41	33.3	0.37	0.00	.....
Grade 3-2	0.33	6.3	5.4	0.50	41.0	0.36	0.00	+ 4.6
Grade 2-2	0.26	86.1	68.3	0.26	99.2	0.37	....	+44.8
Grade 4-5	....	....	....	....	....	....	....	— 0.3
Grade 5-1	....	....	....	....	....	....	....	0.00
High Cr:Ni steel	7.93	Sol.	111.3	0.27	462.8	....	....	—57.1
High Cr:Si steel	0.00	Sol.	....	0.50	....	....	....	.....
25 per cent Ni steel	7.81	9.0	11.0	Sol.	22.3	....	....	.....
38 per cent Ni steel	13.8	4.1	4.1	Sol.	19.0	....	....	.....
Wrought iron	19.3	Sol.	490.0	Sol.	261.5	....	7.20	.....
Copper steel	12.2	96.3	73.4	Sol.	201.2	....	....	— 967
Monel metal	0.70	1.2	1.3	Sol.	13.1	....	0.08	— 338
High Cr steel	0.67	Sol.	Sol.	0.10	457.3	....	0.00	— 520



FIGS. 1 TO 5. TYPICAL MICROSTRUCTURE OF REZISTAL

Fig. 1. Ingot of grade 2. Brinell No. 179.
Fig. 2. Transverse section of sheet made from the same material as shown in Fig. 1.
Fig. 3. Hammered bar made from grade 2. Brinell number 228.
Fig. 4. Same as Fig. 3, after being held one month at approximately 900 deg. C. Brinell number 302.
Fig. 5. Grade 2, air-quenched after one hour at 1,100 deg. C. Brinell number 223.

which is a fairly good range. This ought to make very good material for bottles for transporting liquid air, as it did not become brittle at the lower temperatures.

Physical Properties

Figs. 1 to 5 show typical microstructures. Ingots show cored structure. Heat and work convert this into polyhedral crystals of a solid solution—sometimes laminated—which persists to high quenches, finally recrystallizing at about 400 deg. C. Quenching from five minutes at 1,300 deg. C. gives very course polyhedral grains with faint ghost-like markings suggesting the old location of bands of flattened crystals. The original paper gives many tests after various heat-treatments; from which the following in Table II have been selected to indicate what results can be had.

Modulus of elasticity of Rezistal is about 27,200,000 in tension and 11,700,000 in torsion. In 0.038-in. sheets (Brinell 244) it will stand three or four 90-deg. reverse bends, and can be bent flat around a pin four thicknesses in diameter without cracking. Various grades have impact strength of from 16 to 53 ft.-lb., being highest in specimens oil-quenched from 1,200 deg. C.

For machining, this steel should be heated at about 800 to 850 deg. C., held there until thoroughly heated and then allowed to cool to room temperature before it is taken out of the furnace. It can then be machined, drilled or milled with high-speed tools. For cutting to length, a friction saw running at high speed or a thin carborundum wheel can be used. The best method found so far is to use a thin metal slitting saw of regular standard high-speed steel. This steel cannot be cut successfully with an ordinary hacksaw.

When annealing for cold-forming, the steel should be brought to a temperature of 1,150 to 1,200 deg. C. and held at this temperature for one-half hour in thicker sizes. In thin sheets it need not be held more than five or ten minutes; then turned over and held ten minutes more. It should then show a scleroscope hardness of 30.

This steel can be welded best with the oxyacetylene flame and a suitable flux, using a strip of the same material to fuse the edges together. The sand-blasted

TABLE II. PHYSICAL PROPERTIES OF REZISTAL

Grade	State	Yield Point	Ultimate Strength	Elongation	Reduction in Area	Hardness (Brinell or Shore)
2-1	As rolled	107,300	146,900	25.5	40.1	302
2-1	Oil-quenched from 1,320 deg. C.	56,600	109,500	67.5	67.5	187
3-2	As rolled	85,700	118,000	33	48.2	228
3-2	Oil-quenched from 1,040 deg. C.	75,100	113,100	39	60	228
2-6	Air-quenched from 900 deg. C.	79,600	130,200	33.5	28.3	50
2-6	Oil-quenched from 900 deg. C.	75,800	137,900	3805	33.9	50
2-6	Water-quenched from 900 deg. C.	77,400	130,400	36.5	36.4	50
3-8	Water-quenched from 600 deg. C.	111,600	126,900	25	37.9	55
3-8	Water-quenched from 850 deg. C.	98,500	131,300	31	37.9	47
3-8	Water-quenched from 1,050 deg. C.	78,700	120,700	45	45.7	40
3-8	Water-quenched from 1,200 deg. C.	57,900	99,400	60	51.1	38
3-8	Air-cooled after 1 hr. at 1,300 deg. C.	53,900	99,200	43.5	43.6	...

or pickled sheets should weld the best; if scale be still on the sheets, it may interfere seriously with the welding. This material gives excellent welds on cast iron by the electrical welding method.

Established Uses

Rails, racks and trays in enameling furnaces ranging from 1,600 to 1,800 deg. F. where ordinary steels scale heavily at these temperatures.

Valves and parts for internal combustion engines to resist high temperatures together with corrosive fumes.

Cooking utensils, such as pots, skillets, etc., that are to be kept bright.

Spatulas, paper cutters, trays in gas ranges that burn and rust readily when made of ordinary steel.

Vault plates and hinges that are to resist attack of oxy-acetylene flame and burglars' saws and drills.

Annealing and case-hardening boxes.

Flue dampers in furnace stacks.

Rivet-heating furnaces.

For instruments in all places where a steel is desired that is of the lowest magnetic susceptibility.

Containers for acetic acid and other corrosive organic acids.

Shafts for motor boats to resist sea water.

Paring knives for fruits and vegetables.

Rifle and shot gun barrels, stainless, non-rusting and non-corroding from ammunition.

Cast lead pots.

Cast cyanide pots.

Cast parts of rivet-heating furnaces.

Rust-resisting wire for umbrellas.

Wire of high electrical resistance (560 ohms per mil ft.).

Hardening trays for steel stamps.

Proposed Uses

Boiler tubes—either water or fire tubes.

Boxes for safe deposit vaults.

Planes for aircraft, light and having great strength and ductility in thin sections for highly stressed parts.

Oil burners.

Tips for oxyacetylene cutting torches.

Roof gutters and conductors.

Check valves and valves of all kinds in steam lines.

Pipes and tanks for carrying commercial sulphuric and nitric acids at atmospheric temperatures.

Pipes for corrosive mine waters.

Pickling vats and rods for same.

Nails for resisting acids.

Hotel and kitchen cutlery, non-breakable, super-stainless, easily sharpened and requiring no heat-treatment by the cutlery manufacturer.

Saw-tooth bread and cake cutters.

Rust-resisting tapes.

Hot plates in laboratories, highly resistant to acid and heat attack.

Muffles for heat-treating furnaces operating at less than 1,100 deg. C. (2,000 deg. F.).

Hoods and running boards for automobiles.

Turbine blades.

Fertilizer pans.

Tubes for annealing needles.

Dies for die casting.

Pyrometer-protection tubes.

Valves and valve seats for steam traps.

Polished surfaces of flatirons.

Golfstick heads.

Hooks and wires for suspending parts to be hardened at high temperature, such as high-speed steel.

Perforated bottoms for tanners' tanks.

Art vases and statuettes.

Tunnels for manufacture of lamp black.

Wire spokes for automobiles, motorcycles, bicycles, etc.

Burial caskets.

Mine water pumps and machinery, highly resistant to cold sulphuric acid.

Castings for resistance to acetic, sulphuric and nitric acids at ordinary temperatures.

Castings to resist rusting at atmospheric temperatures and to resist scaling at temperatures up to 1,100 deg. C. (2,000 deg. F.).

Wire of great toughness and rust resistance, for mine cables and cables for incline planes.

Runners for ice boats.

Punties for polishing glass.

Rods for skimming brass.

Wire to stand red heat continuously in shoe machinery.

A Hardened Lead for Bearing Metal

IN DISCUSSING P. H. Brace's paper on Calcium[1] presented before the last meeting of the British Institute of Metals, R. T. Rolfe, a member, wrote that he was particularly interested in lead alloys containing calcium and other alkaline earth metals designed to replace ordinary tin-base alloys for bearing purposes.[2] This application apparently arose out of the war-time scarcity of tin. One of the proprietary alloys sold for this purpose which he had used experimentally for the lining of some main and connecting-rod bearings for a hot-bulb oil-engine gave on analysis the following results:

INGOT METAL AS RECEIVED

	Per Cent		Per Cent
Antimony	nil	Zinc	0.04
Arsenic	0.01	Magnesium	nil
Tin	nil	Barium	1.30
Copper	0.04	Calcium	0.79
Bismuth	nil	Lead	97.05
Aluminum	nil	Oxygen (difference)	0.66
Iron	0.11		100.00
Nickel	trace		
Cobalt	nil		

This alloy was stated to contain "from 97 per cent to 98 per cent of lead, the balance being barium and calcium used as hardening elements," with which specification the analysis agreed very well.

A photomicrograph, magnified 150 diameters, of the alloy, etched with acid ferric chloride, is shown in Fig. 1, and depicts the hard spots of the intermetallic lead-alkali compound set in a lead matrix, the structure being thus typical of a normal bearing alloy.

The lead so hardened, which was manufactured by an electrolytic process, was certainly much harder than ordinary lead, as would be seen by the comparison below of the Shore and Brinell hardness figures of the two:

	Brinell Hardness Figures		Shore Hardness Figures	
	Load 500 Kg.	Load 1,000 Kg.	Ordinary Hammer	Magnifier Hammer
"Hardened" lead	31.2	26.5	7.5	13.5
Ordinary lead	8	(Unmeasurable)	2	3

Again, the "hardened lead," when struck by a hammer, emitted a distinct "steel-like" ring, in marked contrast with the note obtained from ordinary lead.

The alloy was stated to have been tested in properly

[1] CHEM. & MET. ENG., vol. 25, p. 105 (July 20, 1921).

[2] *Jour. Institute of Metals*, vol. 25, p. 171.

FIG. 1. LEAD, ALLOYED WITH BARIUM AND CALCIUM. × 150. ETCHED WITH ACID FERRIC CHLORIDE

designed bearings up to a pressure of 6,000 lb. per sq.in., with satisfactory results.

Mr. Rolfe was not in a position to say how the bearings lined with this alloy compared in service with those lined with ordinary white metal of Admiralty composition. In the meantime there were several points which required consideration as regarded the possible replacement for bearing purposes of the ordinary white metals by such an alloy.

In melting this alloy there was an oxidation of the calcium and barium, much more dross being produced, particularly if any stirring was done, than with the tin-base alloys. The ultimate end would be that the hardening effect would disappear, the lead reverting to the ordinary variety. To avoid this, it was therefore advisable not to have a pot of the metal standing molten, but to melt down the required quantity at the moment it was to be used. It would appear that there was likely to be a certain amount of oxidation in the metal as manufactured, which would increase with remelting, some oxide being mechanically contained, the rest being rejected. It would be noted that, in the analysis of the metal first quoted, a deficiency of a little more than ½ per cent, not found by a very careful search for any other possible metals, has therefore been described as "oxygen."

In lining the bearings referred to, a temperature of about 450 deg. C. was found to be the best at which to pour. It was necessary to have the mandrel fairly hot. If feeding was not properly done, a shrinkage cavity was left just below the point at which the metal was run in.

Cost Comparisons

The alloy in question cost £100 per ton at a time when the cost of the white metal alloy of Admiralty composition (tin 85 per cent, copper 6.5 per cent, antimony 8.5 per cent) was £210 per ton. On the other hand, owing to the greater specific gravity of the lead alloy (11.04 against 7.20), the cost, volume for volume, became £167 for the lead alloy, as compared with £210 for a ton of Admiralty composition white metal. The "hardened lead" therefore showed a saving of about 20 per cent as compared with Admiralty white metal, but approached fairly closely in cost to some of the tin-base metals in which a proportion of lead was added, but which, however, were quite as satisfactory for general bearing purposes as the Admiralty alloy. For example, the alloy 70 per cent tin, 6 per cent antimony, 6 per cent copper and 18 per cent lead had been demonstrated by Mr. Rolfe to be as reliable in service as the other, while its cost would have been £180 as compared to £210 for the other.

"Hardened lead" was claimed to be a better bearing metal than tin-base alloys, although this appears doubtful. It would be seen, however, that there was no such advantage on the score of cost as might be expected from an alloy composed of about 98 per cent lead.

Permanency of hardness in this bearing alloy was said to be fully maintained after extended periods of use. The decrease in hardness up to 200 deg. C. was stated to be less than in the case of tin-base alloys.

There is at present no information on the relative corrodibility.

The writer would be much indebted to Mr. Brace if he could afford any further information, particularly as to the behavior of "hardened lead" bearings in service, in, for example, high-speed inclosed engines, turbines, etc.

Mr. Brace also noted that alloys of this type had found successful application to crankshaft bearings in American automobile engines. Oxidation was so troublesome when casting thin sections that the Westinghouse company had not used these alloys to any extent. It found that whereas the Brinell hardness of freshly cast metal was about 12 (10 mm. ball, 500 kg. load) it increased to about 20 upon aging.

Regenerative Furnaces for Heat-Treating*

LIKE the thermally efficient gas or oil engine, the regenerative furnace has its limitations as well as its field of usefulness. It is an efficient type of furnace for releasing and utilizing heat from fuel, and is particularly suitable for the use of fuels, such as producer gas, which, by reason of chemical composition and low calorific intensity, will not produce high temperatures without regeneration.

The regenerative principle, by recovering a part of the sensible heat carried out of the heating chamber by the spent gases, and utilizing it to preheat the air or fuel, or both, permits a high hearth temperature and results in economy of fuel.

The regenerative furnace should be considered when the temperature and nature of the heating process, the size of the furnace, the cycle of operation or the plant conditions will not permit of a simpler or cheaper method of securing the result desired.

Regeneration, like recuperation, is really an indirect method of utilizing or recovering heat, and at times is limited to preheating the air alone, since certain fuels, such as natural gas and other hydrocarbon gases, cannot be preheated to the extent possible with producer gas. When the temperature requirements and plant conditions permit the use of furnaces with more direct methods of utilization or recovery, the regenerative principle is unnecessary. But where a high temperature is required, as for heavy forging, welding or melting operations, it is frequently necessary to resort to regeneration in order to establish a sufficient temperature differential, to increase the rate of heating, or to make possible the attainment of the desired working temperature, regardless of the saving in fuel or cost of furnace.

Considerable time is required to raise the temperature in the renegerative furnace from a comparatively cold condition to a relatively high working temperature. This is objectionable when the furnace is used only 8 or 10 hours per day, unless the heat is maintained between shifts to balance radiation and flue losses. Temperature requirements and the nature of the heating process or of the fuel may, however, make this furnace and practice desirable even under such intermittent operation. The objection does not hold when the furnace is operated continually at working temperature and capacity in two or more shifts.

Practically all regenerative furnaces are of the "batch" type, and therefore are limited in ability to maintain the chamber continually at full working capacity and at uniform temperature.

Regeneration should not be considered when the furnaces required are comparatively small and scattered. The floor space required for a regenerative furnace is

*Extracts from a bulletin (copyrighted) by W. S. Rockwell Co., entitled "The Variety of Furnace."

relatively large, due to the area of the regenerators, reversing valves, flues and chimney, which frequently occupy a greater space than the furnace itself. This, with the heavier foundations required, must be considered with the production requirements, plant conditions and the space available for the furnaces, machines and operatives.

There is a limit in the size of a regenerative furnace below which it is impracticable to go, because the possible economy in fuel is outweighed by other considerations related to the cost of installation and operation.

The tendency to consider the regenerative or recuperative furnace as a possible solution of the so-called fuel problem should lead to consideration of conditions responsible for the limited use of such furnaces in the past and the extent of their use in the future.

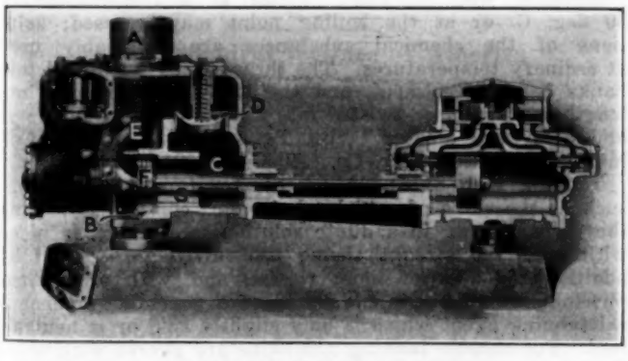
The flexibility of such highly concentrated fuels as natural gas and oil and their relative cheapness in the past made it possible for the manufacturer to conduct many of his heating operations without regard to fuel conservation. As fuel was cheap and apparently not worth saving, the regenerative furnace did not often appeal to him. Production, rather than cost of fuel, was the order of the day. This, with a relatively low labor cost and working conditions not now countenanced, have been responsible for the lack of progress in furnace design that should have followed as a matter of course.

Changing conditions and the demand for better quality and decreased cost, coupled with relatively higher prices for material, fuel and labor, will compel an increasing appreciation of all the factors that control the selection and use of furnaces and fuels for the production of heat-treated products.

Magma Pump

A special pump designed to handle viscous fluids such as tar, heavy crude oils, pulp, molasses, etc., has been developed recently by the A. S. Cameron Steam Pump Works.

These Cameron Magma pumps are of the direct-acting piston plunger type operated either with steam or compressed air. The pump end is of special construction, with ports of such generous proportions that



CAMERON MAGMA PUMP

the liquid and foreign matter, held in suspension, are afforded unimpeded passages; also the discharge valves, instead of being of the flat type, are bowl-shaped and easily reseat themselves by the inclosed valve spring when the piston starts in the reverse direction. These discharge valves are particularly simple in construction, operate in a vertical plane and are very accessible.

The pump cylinder has either a removable cast-iron or bronze bushing through which a solid grooved piston works. The grooved piston has the effect of helping to keep the bushing lubricated, and also, as this pump is designed to handle viscous fluids, these grooves eliminate the necessity of packing of any kind.

Referring to the sectional view of the pump: *G* is the cylinder, *F* is the piston and *A* the port connected with the source of supply. The necessity for inlet valves is eliminated by having the pump placed below the level of the source of supply. In this way the fluid comes readily into the pump through port *A*. From port *A* it passes into chamber *B*. The piston *F* in its travel closes the port *B*, leaving the fluid free to pass into the opposite end of the cylinder *G*, in which a partial vacuum has been created. The return of the piston forces the fluid into chamber *C* and up through bowl valve *D*. The discharge opening is designated by the letter *E*.

The driving end is of the standard steam-thrown valve type used in other Cameron pumps.

Synopsis of Recent Chemical & Metallurgical Literature

Metallography of the Oxyacetylene Weld as Affected by Enameling.—In the July, 1921, issue of the *Journal of the American Ceramic Society* is an interesting article by Emerson P. Poste, on "The Metallography of the Oxyacetylene Weld as Affected by Enameling." A discussion of the cooling of steel through the critical range is followed by consideration of the general structure of low-carbon material and of mechanical and thermal treatment, including the statement of the essential conditions for annealing. The temperature reached by the steel in the enameling operation is discussed with reference to the annealing temperature. An examination of plates and welds before and after enameling shows that a thorough annealing of the weld is accomplished during the process.

Action of Titanium in Blast-Furnace Slags.—Much attention has been given to the possibilities of commercial utilization of titaniferous iron ores, in view of their abundance, accessibility, high iron content and unusually low sulphur and phosphorus. If the titanium could be handled, the pig iron resulting should be excellent for bessemer steel. Indeed such ores were used for centuries in certain European forges. Despite a 6-year campaign at Sanford Hill, Dr. Forbes' successful experiment in 1868 at Norton, England, Dr. Rossi's more recent work at Niagara Falls, and the large-scale tests in blast furnaces at Port Henry, N. Y., in 1914 and at Patea, New Zealand, titaniferous ores are not wanted by the modern blast-furnace plant.

In the course of studies at Queen's University, Kingston, Ont., it occurred to the investigators that a great commercial drawback is due to the fact that titanium is always reckoned as an acid substance in computing the burden, and a corresponding amount of limestone is added to neutralize it. High titanium in a charge thus meant large amounts of stone and a corresponding low iron. But from its chemical characteristics titanium should act either as an acid or a base, depending upon whether the slag were excessively basic or acid, respectively, much as alumina

TABLE I. TYPICAL SLAGS

	According to Stoughton	According to Feild and Royster	From McIntyre Furnace
FeO	..	..	3.46
SiO_2	33	35	26.72
CaO	41	40	25.81
MgO	11	5.5	5.99
Al_2O_3	12	13	11.86
TiO_2	..	..	25.1

is now supposed to act in furnaces smelting copper or lead ores. W. M. Goodwin in vol. 13, *Transactions* of the Royal Society of Canada, June, 1921, reports some successful experiments designed to prove this supposition.

Comparison of a slag analysis from the McIntyre furnace in the Adirondacks with average analyses quoted in the literature (Table I) substantiated this contention.

An ore containing 67 per cent Fe_3O_4 and 11.8 per cent TiO_2 was therefore mixed with charcoal and sufficient silica sand to give a slag containing approximately 36 per cent SiO_2, and smelted in a small arc furnace. Table II gives

TABLE II. RESULTS OF EXPERIMENTAL RUNS

		1	2	3	4
Slag Analysis:	FeO	2.9	4.0	3.7	3.1
	SiO_2	44.5	35.3	35.6	36.2
	CaO	7.0	6.0	8.1	8.4
	MgO	13.2	12.1	10.8	10.6
	Al_2O_3	13.8	17.5	15.9	16.9
	TiO_2	17.4	26.1	25.6	21.7
	MnO	0.3	0.3	0.6	0.4
Nature		Fluid	Fluid	Very fluid	Fluid
Pig Analysis:	C	2.53	2.53	2.56	3.04
	Si	4.99	3.91	1.28	1.90
	Ti	0.02	0.02	0.01	0.01
Temperature, deg. C:					
Slag stream		1300	1200	1430	1390
Furnace lining		1360	1315	1325	1360

data on the results. Temperatures were taken by optical pyrometers, and for various reasons are thought to be considerably too low. Run 4 was chilled by too-rapid chargings, and the iron could not be tapped. However, all slags were quite fluid, despite the rather wide variation in composition, particularly the silica content. The iron should be suitable for some foundry purposes, or for steel making.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Oxyaldehydes.—Oxyaldehydes are prepared by the interaction of phenols or their derivatives with formaldehyde and a nitroso compound in the absence of an organic solvent. The preparation of vanillin by treating guaiacol and formaldehyde with p-nitrosodimethylaniline in aqueous hydrochloric acid solution is described. (Br. Pat. 164,715; not yet accepted. Société Chimique des Usines du Rhône, Paris. Aug. 4, 1921.)

Electrolytic Iron.—An electrolyte contains iron chloride and an aluminum salt or colloidal alumina. Aluminum chloride or sulphate may, for example, be added, or aluminum dissolved in the iron chloride solution. Hydrochloric acid may be added to redissolve precipitated alumina or to prevent its precipitation; or fresh aluminum salt may be added to compensate for precipitation. A suitable solution contains 200 to 250 g. of iron and 5 to 15 g. of aluminum per liter. Current densities of 5 to 10 amp. per sq.dm. may be used, and the temperature may be 75 to 80 deg. C. Cast iron anodes may be used. (Br. Pat. 164,725; not yet accepted. Société d'Electrochimie et d'Electrométallurgie, Paris. Aug. 4, 1921.)

Sodium Cyanide.—Sodium cyanide is obtained from mixtures or solutions containing it together with sodium chloride and alkaline earth compounds such as the product obtained by fusing calcium cyanamide with sodium chloride, by precipitating the alkaline earth by adding a suitable sodium salt, such as sodium sulphate or carbonate, and concentrating the solution at the same time, or subsequently so as to salt out the sodium chloride and leave the cyanide in solution. For this purpose sodium cyanide, or its mixture with sodium chloride, may be added to the solution. If an excess of cyanide is used the part remaining undissolved may be recovered by leaching the remaining solids. (Br. Pat. 164,719; not yet accepted. Deutsche Gold und Silber-Scheide Anstalt, vorm. Rössler, Frankfurt-on-Main, Aug. 4, 1921.)

Electrolytic Chromium.—Chromium is deposited electrolytically from solutions of alkali chromites or mixtures of alkali chromites with other chromium compounds prepared by adding solutions of caustic alkalis to solutions of chromium salts. The alkali should be added in such quantity that the chromite formed is dissolved. In baths containing chrome alum or chromium sulphate, the green form should be use. (Br. Pat. 164,731; not yet accepted. E. Liebreich, Berlin. Aug. 4, 1921.)

Drying and Liquefying Nitrous Gases.—Water is removed from the gases produced by the oxidation of ammonia, to enable them to be condensed without injury to the refrigerating apparatus, by spraying with liquid nitrogen oxides in packed towers of known type. Preferably, the gases are first washed with nitric acid of less than 68 per cent strength to secure partial dehydration. Using gases containing from 1 to 19 per cent of nitrogen oxides and liquid nitrogen oxides, both at 15 deg. C., and with a preliminary washing with nitric acid of 15 to 50 per cent strength, the issuing gases are cooled to —2 to —20 deg. C., owing to the loss of latent heat of the evaporated nitrogen oxides. The gases, being practically free from water and nitrous and nitric acid vapors at this temperature, are then liquefied by cooling—for instance to —100 deg C.—in a refrigerating apparatus such as is used for condensing nitrogen oxides obtained by the oxidation of nitrogen. A portion of the liquid nitrogen oxides so obtained is used for treating further quantities of nitrous gases. (Br. Pat. 164,734; not yet accepted. Officine Electrochimiche Dr. Rossi and C. Toniolo, Legnano, Italy. Aug. 4, 1921.)

Tropine Derivatives.—Tropinone monocarboxylic ester is obtained by partial saponification and elimination of carbon dioxide from tropinone dicarboxylic ester (which can be obtained by condensing together acetone dicarboxylic ester, succindialdehyde and methyl amine). In an example the dicarboxylic ester is boiled with alcoholic potash, acidified, supersaturated with ammonia, and the monocarboxylic ester isolated by extraction with ether or chlorinated hydrocarbons. (Br. Pat. 164,757; not yet accepted. Firm of E. Merck, O. Wolfes and H. Maeder, Darmstadt. Aug. 4, 1921.)

Artificial Silk.—Artificial silk filaments, threads and fibers of cellulose acetate and other esters of cellulose are treated with hot water or steam, solution of ammonium, calcium or potassium sulphocyanide, or acetic acid, and dried without tension, to render them more or less crinkled in appearance and softer to the touch and to reduce their luster, thereby obtaining a product resembling wool or hair. Water at a temperature of 80 deg. C. or at the boiling point may be used; solutions of the chemical substances are preferably used at ordinary temperatures. The threads may be wound into hanks before treatment, and the hanks may be cut into lengths and spun or twisted into chappe or spun silk form and afterward treated. (Br. Pat. 165,164. British Cellulose & Chemical Mfg. Co. Aug. 17, 1921.)

Tanning Fish Skins.—A process for tanning fish skins, such as the skins of catfish, skate, etc., consists in salting the skins; liming in a dilute solution, preferably softened with soda, the strength being progressively increased by additions of milk of lime; rinsing and, with or without puering, submitting to the action of a vegetable or chemical tanning agent which is only slightly acid or is neutralized. For chrome tanning, the skins are puered with weak chicken manure, then treated in a solution of sodium chloride to which hydrochloric acid is added gradually in increasing quantities. After soaking in soft water, the skins are then tanned in pure chromate in gradually increasing quantities, with or without the addition of hydrochloric acid. They are then washed in soft water and protected from the action of light, being subsequently treated with sodium thiosulphate or with soda and finally freed from acid by means of tepid water and chalk. (Br. Pat. 165,199. E. Knudsen, Orkadalen, Trondhjem, Norway. Aug. 17, 1921.)

Current Events
in the Chemical and Metallurgical Industries

Many Plants Resuming Operations

Glassware.—The Ball Bros. Glass Mfg. Co., Muncie, Ind., manufacturer of fruit jars, is arranging for the immediate resumption of operations at its plant, giving employment to about 1,000 workers. For some time past only about 200 operatives have been engaged at the plant

The Lippincott Glass Co., Alexandria, Ind., has resumed the operation of its 20-pot furnace, giving employment to about 300 persons on a division of time. It is planned to place all departments in service at an early date, with working force totaling about 500 men.

The Kane Window Glass Co., Kane, Pa., has resumed production at its plant, with employment of about 250 men. The American Window Glass Co., in the same city, has arranged for the immediate operation of a portion of ts plant, employing about the same number of operatives.

Ceramic.—The Metropolitan Paving Brick Co., Canton, Pa., has placed its entire seven plants in operation for the first time in several years.

The W. S. George Pottery Co., Canonsburg, Pa., is operating on a normal basis, with employment of the usual working force. The Canonsburg Pottery Co., with plant on Meadow Lane, is also engaging under normal production.

The Standard Sanitary Manufacturing Co., Louisville, Ky., has adopted a night working schedule at its plant, giving employment to about 100 men. It is expected to increase this number to about 400 operatives gradually.

Rubber.—The New Jersey Rubber Co., Lambertville, N. J., has adopted a night schedule of operation at its mill on certain days.

Paper.—The Jessup & Moore Paper Co., Wilmington, Del., has resumed production under a 24-hour working schedule at its local paper mills, and at its pulp mills at New Castle, Del. Increased operations are also under way at the company's plants at Providence and Elkton, Md.

Metal. — The National Enameling & Stamping Co., Granite City, Ill., has resumed operations at its plant, following a shut-down for several months. Three furnaces will be used at the present time.

Sugar.—The American Sugar Refining Co., 117 Wall St., New York, N. Y., has resumed operations at its Chalmette refinery, following a shut-down of several weeks. All of the other refineries of the company are now in operation.

The Chemical Welfare of America

A very strong plea for the continuation of the license system, covering the admission of dyes and fine organic chemicals into the United States, was made Thursday noon, Oct. 13, by Dr. Ellwood Hendrick in an address before the Rochester Chamber of Commerce on the subject "The Chemical Welfare of America."

The license system was adopted at the request of President Wilson and was continued at the request of President Harding. It is virtually an embargo against German dyes and fine chemicals, but it permits importation of any chemical or dye which is not produced in the United States in quality, quantity or at a price making it desirable for use. Dr. Hendrick pointed out that if this embargo is not renewed when it expires Germany is in a position to flood the United States with dyes manufactured with cheap labor and from cheap raw materials so that within two weeks the dye industry of this country would be wrecked.

The history of the dye industry from its beginning in England in 1856 was outlined. Dr. Hendrick showed clearly how that "key" industry fell into the hands of capitalists who, of course, immediately eliminated all scientific research work and operated simply on a money-making basis.

The Germans, being rich after the Franco-Prussian war, took up the dye industry and developed the scientific side. So within the period of the following forty years they not only developed the science of dye chemistry to a very high point but evolved the many chemical byproducts which are now common drugs, medicines and other useful organic chemicals. But the Germans also developed a new line of research which was unknown to the world until the fateful fall of Liége—the making of poison gases. These are direct products from the experimentation carried on in the dye factories of Germany.

Between 90 and 95 per cent of all the dyes needed can now be manufactured without difficulty in the United States, and these dyes can be made at a cost which will not unnecessarily add to the cost of the dyed materials. Two cents worth of dye will color a dozen pairs of stockings and the cost of dye for an excellent suit of clothes never exceeds the half-dollar mark. So the cost of dyes becomes a very insignificant factor. Labor costs, being high, tend to make the American dyer skimp in the use of his dyes and complaints result.

The plea for the preservation of the dye and organic chemical industry in the United States is not based alone on the value of this industry in its production of dyes and chemicals but on the fact that the plants stand always at the command of the Government, not to recruit or train soldiers or to incite warlike feeling, but as laboratories where scientific research may be continually carried on and which will immediately become arsenals of chemical warfare munitions.

Naturally everyone sincerely hopes that war will never come again, but should such a frightful thing occur the country that is making the greatest progress in science will be best equipped to turn out munitions of the nature that will insure its success.

Agreements for the limitation of armaments or elimination of chemical warfare are very good as far as they go. However, wars usually follow the breaking of contracts between nations and "when once the fight is on the lid is off."

"The opponents of the license system include the owners of certain woolen mills, the Amoskeag Company of New Hampshire and a number of sincere persons who are uninformed on the subject and who, like most of us, hate the word embargo," said Dr. Hendrick. "I would not number among those uninformed persons Senator Moses of New Hampshire, who, whatever his motives may be, conducts himself like an attorney for the Amoskeag Company, and leads the opposition for the licensing system."

"In favor of the continuance of the license system you will find the American Chemical Society, the American Drug Manufacturers Association and countless other organizations as well as large numbers of individuals who are fully informed on the real situation."

Over one hundred members of the Rochester Section of the American Chemical Society were in attendance with the business men to hear Dr. Hendrick.

Conference on Soap Specifications Planned

The soap section of the American Specialty Manufacturers' Association, which represents 90 per cent of the soap manufacturers of the country, has appointed a committee consisting of A. Campbell, of the Globe Soap Co., St. Bernard, Ohio, chairman; W. H. Raymond, of Armour & Co., Chicago; H. M. Thayer, of N. K. Fairbank & Co., Chicago, to confer with soap chemists of the Bureau of Standards of the Department of Commerce relative to the revision of soap specifications which are contained in Bureau of Standards Circular 62, issued in 1916. It is expected that a conference with the committee will be arranged shortly.

Industrial Cost Association to Meet

From Nov. 2 to 4 the Industrial Cost Association will hold its second National Cost Conference at the William Penn Hotel, Pittsburgh. Sessions will be open to members and executives and department heads of industrial plants. The advance program follows:

WEDNESDAY, NOV. 2

10:30 a. m. Opening of conference. Address by Horace S. Peck, comptroller, S-K-F Industries, Inc., New York, and national president, Industrial Cost Association.

1:45 p. m. Address of welcome. E. V. Babcock, Mayor of Pittsburgh and president, Babcock Lumber Co.

2:15 p. m. "What the Sales Manager Should Have From the Accounting Department," S. B. Taylor, general sales manager, S-K-F Industries, Inc., New York City.

4:15 p. m. "Inventories: Methods of Completing the Physical Count," E. C. Grimley, Victor Talking Machine Co., Camden, N. J. Discussion led by Christopher Haigh, supervisor of costs, General Electric Co., West Lynn, Mass.

8 p. m. "Responsibility of the Comptroller or Accountant in Times of Business Depression," F. S. Willett, comptroller, Dodge Manufacturing Co., Mishawaka, Ind. Discussion led by F. C. Poag, analyst, Allied Chemical & Dye Corporation, New York.

9:30 p. m. "Idleness and Its Relation to Industry, in Retrospect," T. W. Dinlocker, assistant comptroller, S-K-F Industries, Inc., New York, and A. W. Wainwright, works auditor, Skayef Ball Bearing Co., Hartford, Conn.

THURSDAY, NOV. 3

9 a. m. "Terminology," Addison Boren, Yale & Towne Manufacturing Co., Stamford, Conn., chairman, National Terminology Committee, Industrial Cost Association.

10 a. m. "Budgeting the Plant and Office," H. S. Breitenstein, chief accountant, Bureau of Accounting Revision, Department of Controller, City of Pittsburgh. Discussion led by Weston J. Hibbs, treasurer, U. G. I. Contracting Co., Philadelphia.

2 p. m. "Sanitation and Safety," J. B. Ayres, sanitation and safety engineer, National Tube Co., National Works, McKeesport, Pa. "Cost and Profits of Welfare, Sanitation and Safety," Major William Hogg, assistant to vice-president, National Tube Co., Pittsburgh, Pa.

7 p. m. Informal banquet, President Peck, toastmaster. "Looking Into the Future," Newcomb Carlton, president, Western Union Telegraph Co., New York. "Federal Taxation," Sanford Robinson, New York City.

FRIDAY, NOV. 4

9 a. m. "How Can a Cost System, Although Efficient, Demoralize an Organization?" J. M. Howell, supervisor of costs, General Electric Co., Schenectady, N. Y. Discussion led by Ernest J. Wessen, cost engineer, W. T. Rawleigh Co., Freeport, Ill.

10:30 a. m. Reports of committees on "Distribution of Burden in Abnormal Times," "Trade Association Uniform Cost Systems," etc.

2 p. m. Plant visits.

All those planning to attend the conference are requested to notify immediately the national secretary, A. A. Alles, Jr., 2828 Smallman St., Pittsburgh, Pa.

Industrial Electric Heating Directory Planned

The Industrial Heating Division of the Power Sales Bureau of the National Electric Light Association is about to compile a directory of manufacturers and users of industrial electric heating equipment.

This includes the following equipment which is electrically heated: Steel furnaces, non-ferrous furnaces, heat-treating furnaces, japanning ovens, drying ovens, core ovens, bread-baking ovens (commercial), welding, rivet heating, electrochemical equipment.

Manufacturers and users of such equipment are requested to furnish data to R. T. Kaighin, care of Cleveland Electric Illuminating Co., Cleveland, Ohio.

Program, American Gas Association Meeting

The third annual convention and exhibition of the American Gas Association will be held in Chicago, Nov. 7 to 12, with headquarters at the Congress and Auditorium hotels. The following program has been arranged for the Technical Section:

WEDNESDAY AFTERNOON, NOV. 9, 2 O'CLOCK

Opening remarks and report of chairman, R. B. Harper, Peoples Gas Light & Coke Co., Chicago, Ill.

Report of nominating committee and election of officers, L. R. Dutton, chairman, Philadelphia Suburban Gas & Electric Co., Jenkintown, Pa.

Paper: "What Goes On in a Water Gas Machine?" M. E. Benesh, Peoples Gas Light & Coke Co., Chicago, Ill.

Report of committee on complete gasification of coal, A. W. Warner, chairman, Philadelphia Suburban Gas & Electric Co., Chester, Pa.

Report of gas oil committee, W. H. Fulweiler, chairman, United Gas Improvement Co., Philadelphia, Pa.

Report of refractory materials committee, W. H. Fulweiler, chairman, United Gas Improvement Co., Philadelphia, Pa.

THURSDAY AFTERNOON, NOV. 10, 2 O'CLOCK

Report of committee on increasing distribution capacity, C. N. Chubb, chairman, United Light & Railways Co., Davenport, Ia.

Paper: "Utilization of Compressed Air for Clearing Gas Piping," J. T. Griffin, Consolidated Gas, Electric Light & Power Co., Baltimore, Md.

Report of committee on consumers' meters, J. A. Clark, Jr., chairman, Public Service Gas Co., Newark, N. J.

Report of cast-iron pipe standards committee, Walton Forstall, chairman, United Gas Improvement Co., Philadelphia, Pa.

THURSDAY AFTERNOON, NOV. 10, 2 O'CLOCK

Report of chemical committee, C. A. Lunn, chairman, Consolidated Gas Co., New York, N. Y.

Report of purification committee, A. C. Fieldner, chairman, Bureau of Mines, Pittsburgh, Pa.

Effect of moisture on activity and capacity of iron oxides for gas purification, William A. Dunkley, Bureau of Mines, Urbana, Ill.

Seaboard liquid process for gas purification, F. W. Sperr, Jr., Koppers Co., Pittsburgh, Pa.

Determination of hydrogen sulphide in illuminating gas, C. W. Jordan, United Gas Improvement Co., Philadelphia, Pa., and W. H. Fulweiler, United Gas Improvement Co., Philadelphia, Pa.

FRIDAY AFTERNOON, NOV. 11, 2 O'CLOCK

Paper: "Some Experiments With the Mixing of Different Gravity Gases in Holders," H. E. Bates, assistant to engineer, Peoples Gas Light & Coke Co., Chicago, Ill.

Report of commmittee on deposits in gas pipes and meters, O. A. Morhous, chairman, Consolidated Gas Co., Astoria, L. I., N. Y.

Report of carbonization committee, J. Hawley Taussig, chairman, U. G. I. Contracting Co., Philadelphia, Pa.

Report of committee on disposal of waste from gas plants, F. W. Sperr, Jr., chairman, Koppers Co., Pittsburgh, Pa.

In addition, a paper, "Why Should Gas Companies Sell Their Tar to Distillers Instead of Working It Themselves?" by R. P. Perry, vice-president The Barrett Co., will be presented at the general session, Thursday morning, Nov. 10, at 10 o'clock.

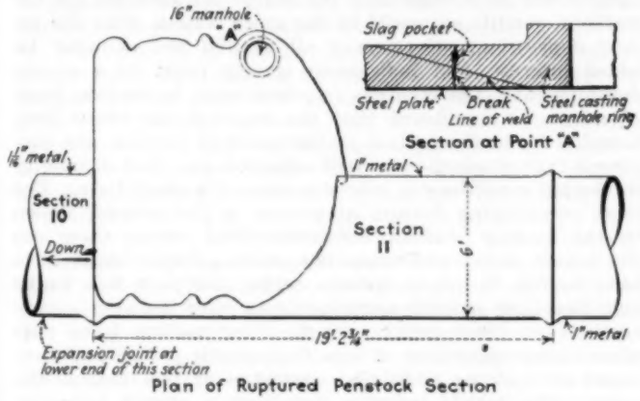
To Study Medicinal Properties of Gases

Studies of the physiological effects of war gases has led some of the chemists of the Chemical Warfare Service to believe that certain gases may be beneficial in the treatment of diseases of the nose, throat and lungs. Some research along that line is to be attempted at Edgewood and General Fries is acquainting medical schools and research institutions with these findings in the hope that they may take up experiments of that character.

Hammer-Welded Joints in Penstock Withstand Bursting Pressures

Engineering News-Record for Oct. 20, 1921, reports the bursting of a 6 ft. hammer-welded penstock on the Big Creek No. 8 hydro-electric plant of the Southern California Edison Co. The break occurred immediately after a short circuit on the electrical system had caused a corresponding disturbance in the hydraulic lines; in fact, the conditions were such that a severe water hammer may easily have caused excessive pressure in the pipe. The static head at the point in question was 560 ft., the pipe had passed a shop test 50 per cent in excess of this load, and the completed penstock had been tested under full static head without indicating any weakness.

A sketch of the pipe, furnished by the M. W. Kellogg Co., the maker, is shown in the accompanying illustration.



Plan of Ruptured Penstock Section

Early reports stated that near point *A*, a ½ x 2½-in. discoloration on the fracture indicated a defect in the weld between plate and manhole casting. Microscopic examination of the metal by the New York Testing Laboratories showed this defect to be an accumulation of slag inclusions in the cast metal. Doubtless this defect was responsible for initiating the tear. The break passed along the manhole-ring casting, but did not cut across the ring. Except at this manhole, the break did not follow welded joints, but went through original metal. The longitudinal tear crossed a circumferential weld, and the circumferential part of the break occurred about a foot beyond that weld. In all there were 5,000 lin.ft. of hammer-welded joint in the penstock, none of which gave any evidence of weakness under the unusual stresses set up by the accident.

Labor Troubles in the German Chemical Industry

A message from Frankfort-on-Main says that the Chemical Industry Employers' Union and representatives of the workers' unions have come to an agreement respecting the resumption of work in the factories which have been closed —the Chemische Fabrik Griesheim-Elektron at Griesheim, the Farbwerke Hoechst and the Vereinigte Kunstseidefabriken Kelsterbach.

The agreement is based on the chemical industry's imperial tariff and the chemical industry's district agreement. The reinstatement of the dismissed workers will take place as requirements demand and as the managements of the works shall decide. No indemnification for the days lost will be paid.

The staff of the Griesheim-Elektron works has rejected this agreement by 1,202 to 236 votes, but less than 50 per cent of the workers used their votes.

Dye and Chemical Control Extended

By an overwhelming vote on Oct. 18 the House of Representatives passed the bill extending until Feb. 1 the emergency tariff bill, one section of which authorizes the control of the imports of dyes and certain chemicals. The dye control feature of the bill did not receive general discussion, although Representative Frear of Wisconsin took advantage of the opportunity to denounce the Chemical Foundation and the embargo plan of protecting the dye industry. Mr. Frear took exception to remarks attributed to Mr. Garvan intimating that the German dye trust is able to influence members of the United States Senate and House of Representatives. So far as his own attitude is concerned, Mr. Frear stated, he is influenced "by the fact that the American public was paying four prices for its dyes and poor dyes at that."

In the course of his remarks Mr. Frear intimated that the investigation of the so-called dye lobby authorized in July might be taken up in the near future.

Glass Standardization Conference

Standardization of the different kinds, qualities and sizes of window and plate glass used as a building material and for many other purposes was discussed at a conference of glass distributors, architects and engineers of the Bureau of Standards of the Department of Commerce held on Oct. 19, at the Bureau of Standards.

Confusion is declared to exist in the glass and glazing fields so far as qualities and sizes of glass are concerned, and this conference outlined a program that will be participated in by the manufacturers, distributors, architects and the Bureau of Standards, and which it is believed will result in the elimination of unnecessary sizes, standardize quality and enable a more efficient use of this building material.

The task, as outlined at the conference, included the formation of a commercially usable scientific classification of glass. At present building glass is classified as rolled plate glass, blown cylinder or drawn sheet glass. The plate glass includes polished glass ranging in grade from that used for the highest quality mirrors to that used for skylights, different kinds of glass in which wire netting has been placed to prevent shattering and ornamental glass of various sorts. The drawn sheet glass is used for windows in different qualities.

Committees were designated by the conference to gather data on and consider different phases of the window and plate glass situation.

At a later date after the committees have had time to accomplish something, another conference will be called.

Those present at the conference were: J. W. Ginder, office of the Supervising Architect; Sullivan W. Jones, American Institute of Architects; S. F. Voorhees, American Institute of Architects; George H. Mayer, American Window Glass Co., Pittsburgh, Pa.; W. C. McCance, local manager, Pittsburgh Plate Glass Co., Baltimore, Md.; S. C. Gilmore, secretary, Hires-Turner Glass Co.; R. W. Spille, local manager, Hires-Turner Glass Co.; L. P. Forman, American Window Glass Co., Pittsburgh, Pa.; R. J. Potbury, Bureau of Yards and Docks, Navy Department; F. C. Brown, N. F. Harriman, P. H. Bates, W. A. Hull and A. E. Williams of the Bureau of Standards.

New Chemical and Oil Companies

During the month of September 35 new companies, with capital of $50,000 or over, were organized to manufacture chemicals, chemical byproducts, dyes and affiliated products. The total capitalization was $7,450,000, as compared with an aggregate capital of $7,720,000 for 37 companies organized in the same month of last year and $15,495,000 aggregate capitalization of companies in this line organized in August, 1921. The indicated investment of companies in the chemical industry for the first nine months of the present year, January-September, totals $91,835,000, as against $175,642,000 for the corresponding period of a year ago.

Oil companies organized during the same month of September, 1921, totaled 66, with an authorized capital of $50,000 or larger. The total indicated investment of the companies stands at $53,862,000, as compared with $136,100,000 in the same month of a year ago and $141,544,000 in August of the present year. It is the third lowest month for organizations of this character in 1921, the peak month of which was April, with total indicated capitalization of companies of $227,470,000. For the first nine months of the present year the indicated capital investment aggregates $1,046,463,600, divided among 752 organizations. In the corresponding period of 1920, 2,212 companies were formed, with a combined authorized capital of $1,913,976,700.

Personal

J. O. ELTON, recently assistant manager of the Great Falls smelter of the Anaconda Copper Mining Co., is assistant general manager for the International Smelting Co., succeeding O. M. Kuchs.

C. POWELL KARR, metallurgist with the Bureau of Standards and an authority on non-ferrous alloys, has been appointed a member of the engineering committee of the National Research Council, which has to do with investigations of molding sand and foundry refractories.

O. M. KUCHS, who has been assistant general manager in Utah for the International Smelting Co., has become general manager for the Andes Copper Mining Co., with headquarters at Potrerillos, Chile. He sails from New York on Oct. 26.

H. C. PARMELEE addressed the junior and senior classes in chemical engineering at the Sheffield Scientific School of Yale University, Oct. 19.

FLOYD W. PARSONS has been appointed editorial director of *Gas Age-Record*. Formerly Mr. Parsons was editor of *Coal Age*, one of the McGraw-Hill engineering publications, and later conducted a department in the *Saturday Evening Post* under the title "Everybody's Business."

W. N. WATSON and C. F. NORTH, chemists for the U. S. Tariff Commission, have been transferred to the Treasury Department for work in New York in connection with the special investigation of American valuation.

S. L. WILLIS, who was formerly in charge of ceramic investigations for the U. S. Tariff Commission, has resigned to accept a positon with the Corning Glass Co.

W. W. WITMER has recently become associated with the Hoskins Process Development Co., Chicago. Since graduating at Purdue University in 1909 Mr. Witmer has been employed by the du Pont company. He has been located at Repauno, N. J., Barksdale, Wis., Louviers, Col., and du Pont, Wash., holding positions ranging from chemist to assistant manager of the Barksdale plant.

Obituary

Colonel SPENCER BORDEN, chemist and manufacturer, of Fall River, Mass., died suddenly of heart trouble at the Woodstock Inn, Woodstock, Vt., on Oct. 17. He had been associated with Thomas A. Edison in his early work and had organized the New England branch of the latter's business. Colonel Borden was seventy-two years old.

JOHN G. LUKE, president of the West Virginia Pulp & Paper Co. and a pioneer manufacturer of sulphite pulp, died on Oct. 15 in St. Luke's Hospital in New York City, following an operation two weeks previously for appendicitis. Mr. Luke was born on April 29, 1857, in Rockland, Del., where his father was employed as superintendent of the mills of the Jessup & Moore Paper Co. The son entered the employ of this mill at the age of sixteen, and subsequently worked in several of the largest paper mills in this country. As superintendent of the Richmond Paper Co. of Richmond, Va., he became familiar with the sulphite process, which was then in an experimental stage, and from the experience gained in this plant he organized his own company and built a mill at Piedmont, W. Va. This was the beginning of the West Virginia Pulp & Paper Co.

Prof. J. ERNEST WOODLAND, head of the science department of Mechanics Institute of Rochester, N. Y., died on Oct. 17 of apoplexy. Prof. Woodland, who was fifty-five years of age, was formerly a member of the faculty of the University of Rochester and at one time was chairman of the Rochester Section of the American Chemical Society.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Oct. 24, 1921.

The pending railroad strike stimulated buying of chemicals during the past week and the market has shown more action than at any time so far this year. The movement gained more strength as the week progressed and in some directions demand has been greater than the available supply of material. There were some, however, who viewed the situation quite pessimistically and believed that should the controversy be straightened out before the time set for the walkout, conditions would be far more serious than the recent depression. Consumers all around are showing an added interest, and indications clearly point to a steady development. The recovery in prices made by various basic chemicals is significant that the reaction has about been completed and those close to the pulse of trading are convinced that production is well adjusted and that normality in market conditions is only a matter of a short time. The most encouraging feature at present is the interest shown by the leading domestic consumers, and among these are the paper, paint and soap industries. Paper mills have been buying in larger volume during the past few weeks and bleaching powder manufacturers have found a steady market for their entire output. Soap-makers have purchased large quantities of imported caustic potash and were eager to stock up additional quantities at the close of the week. The textile industry has been a steady buyer of chemicals, but purchases were chiefly for small quantities.

CHEMICALS

Prices on *caustic potash*, 88-92 per cent, have once more regained their steadiness under an improved consuming inquiry for spot and future shipments. Some material was available at 5¾c. per lb. for imported, but the general quotation among first-hand holders was 6c. Factors in this product believe that the market is slated for considerably higher prices before the turn of the year. Shipments were nominal, with 5¼c. asked subject to cable confirmation. *Bichromate of soda* is slightly higher on spot, with sales recorded at 7⅞c. per lb. The demand for this product is increasing and sellers state that they have received a greater amount of inquiries during the past week. Producers quote the market at 8c. per lb. Spot supplies of *cyanide of soda*, imported, are very scarce and the market is decidedly stronger and higher. German 120 per cent is quoted at 25c. per lb., which is considered an inside price by the few holders of spot material. Goods afloat are held at 22c. per lb. For the 128 per cent German make afloat 25c. per lb. was named. French 125-128 per cent for shipment is offered at 23c. per lb. Prices on *nitrite of soda* are somewhat firmer and business is reported slightly better, even though actual orders call for small quantities only. Sellers quote the domestic brands at 6¾c. per lb. and the imported at 6¼c. Prices on *prussiate of soda* have advanced sharply since the beginning of the week under an active inquiry and a scarcity of supplies. Holders are asking up to 15c. per lb. for imported material. Sales of spot goods are reported as high as 14¼c. per lb. and this price is also named for October shipment from abroad. November-December shipments are held at 14¼c. per lb. The demand for solid *caustic soda* has continued quite active so far this month. While there still are a few lots at 4c. per lb., the majority of holders are above this level for standard brand goods and quote $4.05 per 100 lb. ex-store. Sales of outside brands have gone through at $3.90 per 100 lb., but these are fast dwindling from the market. Manufacturers are still quoting unchanged figures at the works for contracts over the year. Spot *ammonium sulphate* in double bags for export is quite difficult to locate and odd lots picked up here and there have brought $2.75 per 100 lb. Makers are quoting single bags at $2.75 per 100 lb. ex-dock New

York for small quantities. The market is in an extremely firm position with supplies almost impossible to find and demand very acute both from domestic and export buyers. Prices on *barium chloride* from abroad have been much firmer and quotations from importers are higher at $46@$49 per ton for prime material. Domestic makers are still unable to compete. Prices on *nitrate of soda* are much firmer. Importers have announced an advance in price for futures, but have not named any definite quotation. Spot and future deliveries are higher at $2.35@$2.45 per 100 lb. Imported *permanganate of potash* U.S.P. is quoted lower at 18c. per lb. Single bags of light *soda ash* in less than carload lots are moving freely at $2.10 per 100 lb. and upward. Large dealers state that 2c. per lb. could probably be done for carlots, although the tone of the market is quite firm. Sales of barrels are reported at $2.45@$2.50 per 100 lb. Prices remain unchanged at the works. Trading in *glycerine* during the week was very light, with little variation in price. Dynamite sold at 12c. per lb. and c.p. at 14½c. per lb. in drums. Leading producers of *copper sulphate* are still quoting at the former basis of 5½c. per lb. for carload quantities of standard 99 per cent. large crystals. The tone of the market is somewhat firmer with the advance in copper. There were quantities of imported material on the spot market that sold down to 5c. per lb., but these are being taken off the market very quickly.

Coal-Tar Products

Buying in the coal-tar products industry has been somewhat spotty, with a lack of interest noted early in the week and a decided improvement during the last few days. The latter part of the week was experienced by a constant increase in the number of orders and inquiries and the market all around reflected a renewed activity to a considerable extent. The definite extension of the provisions of the emergency tariff until Feb. 1, 1922, is expected to lead to some fairly good buying, as most consumers have been holding off purchasing until some definite action had been taken. The scarcity of benzene is affecting production of many other products and in some instances makers have had to shut down until supplies can be procured. Resale stocks of most commodities are being taken off the market gradually and makers seem well satisfied with this method of obtaining normality in the market. Prices are generally quoted at former levels, but real business is being transacted at slightly under listed prices. The demand for *benzene* is exceeding the supply and no immediate relief can be seen in view of the present output of coke ovens, which even with the recent increase is only at 25 per cent normal. Resale stocks are very hard to locate and are generally held at 40c. per gal. Refiners' prices for future delivery are 27@33c. per gal. A slight improvement in *naphthalene flakes* was reported, but the balls have remained dormant. Some sellers are inclined to be firmer in their views, but supplies are still plentiful and sales around 6¾c. per lb. are still being made. First hands ask up to 8c. per lb., but not very much business is being placed at these levels. Official Government resellers of *phenol* ask 12c. per lb., but prime goods on the open market can be had down to 9½c. per lb. There were a few sales recorded at 9c. per lb. during the past few days and the inquiry seems to be increasing. Resale stocks of *aniline oil* are large and buying must become far more active before the market can be called steady, even though there is a scarcity of benzene. The general asking price is 18c. per lb., but sales were made at the close of the week down to 17c. per lb. Resellers of *dimethylaniline* are obtaining the passing business at 41c. per lb., which is about 5c. per lb. under the makers. The demand is fairly active and the market is a trifle firmer, as most of the second-hand material is being cleared off the market. Manufacturers of *dinitrobenzene* have sold as low as 21c. per lb. during the week on actual business. Quotations, however, are given at 23@25c. per lb., according to brand and quantity. Producers of *paranitraniline* are quoting former prices of 77@80c. per lb. according to brand. Business around the trade on this product has been more or less fair, but rumors of imported German goods at ridiculously low figures have put a dent in any real trading.

The Chicago Market

Chicago, Oct. 21, 1921.

There was little or no change in the general chemical market during the past two weeks. Most factors report a very good volume of business and all are apparently satisfied. The bulk of the business continues to be for small quantities but occasionally a large order is noted. Prices are firm as a rule although with actual business in sight many of the regular prices can be shaded. This is noticeable especially among the smaller factors. The railroad situation is firming up prices and any radical reductions can scarcely be expected for some time. The fact that quite a few speculators are taking on rather heavy stocks shows that at least some are expecting a rising market.

Industrial Chemicals

The *caustic soda* situation lacks new developments and prices are unchanged. Supplies are not heavy and 4¾c. for the ground 76 per cent and 4c. for the solid were the best prices noted. *Soda ash* continues to move well and is firm at $2.60 per 100 lb. for material in cooperage. *Potash alum* appears to be enjoying a good demand and 5¾c. per lb. for the lump and 6½c. for the powdered were the prevailing quotations. *Sal ammoniac* is rather quiet and supplies are available at 7½c@7¾c. per lb. for the white granular 98-100 per cent. There was a brisk demand for *carbon tetrachloride* and 10¾c. for large drums was the inside figure. *Formaldehyde* is still very quiet, with 12c. per lb. the figure generally named, although this could probably be shaded slightly. *Glycerine* has shown but little activity and the price lacks quotable change. Refiners are asking 14½c.@14½c. per lb. for the large drums.

Caustic potash continues firm and unchanged in price, with supplies available at 6½c. per lb. for the 88-92 per cent grade. *Potassium bichromate* is quoted at 13c.@13½c. per lb. and the soda at 9½c. for single casks. A decline of 1c. per lb. was noted in some quarters on *potassium permanganate*, and U.S.P. crystals of foreign origin are now available at 23c. for small lots. *Bicarbonate of soda* is offered at $2.60 per 100 lb. for single barrels. *Sodium fluoride* is not so active, but prices are unchanged at 11c.@12c. per lb. according to quantity. *Zinc sulphate* is quiet at 3½c. per lb. for the tech. cryst. in single barrel lots.

No changes of any consequence were noted in the list of acids. Supplies are plentiful and are said to be moving well. *Acetic acid* is firm, with supplies of the 28 per cent available at $2.65@$2.75 per 100 lb. and glacial at $10.25 to $10.75. *Oxalic acid* is in fair demand at 17c. per lb. *Citric* and *tartaric acids* are very quiet, with domestic makers apparently in control of the market. *Hydrochloric acid* is quiet and unchanged as to price.

The Iron and Steel Market

Pittsburgh, Oct. 21, 1921.

There has been very little change in the iron and steel market situation in the past week. There was such steady increase in demand after the turn that occurred about the middle of July that a failure in the market to improve seems very like a backset, and this may account for the somewhat unfavorable view of the market situation entertained in some quarters this week.

There is no evidence, however, that demand for steel products has actually fallen off in any particular. The record of production up to this week is one of practically constant increases. Steel ingot production seems now to be at somewhat more than 35 per cent of capacity, this comparing with an average rate of about 32 per cent in September, while at the low point, about the middle of last July, the rate was under 20 per cent.

As everyone is more or less interested in the threat of a railroad strike, beginning October 30, there has naturally been an effort to discern an influence of the strike talk upon the state of the steel market. It does not appear, however, that the actual market has taken much cognizance of the possibility of a railroad strike, and that is natural enough after all, for what should a buyer or seller do if he expects a railroad strike? Should he buy or not buy, or should he sell or not sell?

Of more importance to the steel market, unquestionably,

is the matter of freight rates. Reductions have been expected for a long time, and buyers are probably taking more interest now, seeing that there is a somewhat nearer approach of the expected reductions. Producers of steel, in defending their prices during the last few months, have laid much stress upon the influence of high freight rates on their raw and intermediate materials, in making high costs as compared with conditions in 1913, and therefore high selling prices. Naturally buyers of steel would expect lower prices in the event of freight rate reductions. Whether this would affect their buying conduct is a question, if it is true as has been claimed that at best purchases of steel have been for immediate utilization only. Forward buying has been absent from the market, and buying for immediate use could not well be postponed. As to freights on steel bought, buyers would in general get the benefit of rate reductions irrespective of date of purchase, since sales are usually made on a delivered basis with a freight allowance.

Operations

As formerly, the sheet branch leads the divisions of the finished steel trade in point of mill activity, with an operation of about 90 per cent in the Steel Corporation's sheet mills and an operation probably over 75 per cent among the independent sheet mills. The trend, however, is slightly downward. Tin plate mill activity is distinctly on the decrease, with an operation of 50 to 55 per cent this week, but the bulge in activity that began in September was quite out of season. The various wire and pipe mills are operating generally at between 40 and 60 per cent. These are high percentages when the rate of ingot production is not much over 35 per cent, but operations at bar, shape, plate and rail mills are very light. Bar mills are doing the best of the four classes. Structural mill operations have been increasing lately. The Bridge Builders' and Structural Society reports fabricated steel lettings in September at 48 per cent of the fabricating shop capacity, against 33 per cent for August and an average of 28 per cent in the eight months ended with August. A few releases on rail contracts have been received in the past two or three weeks, but rail production is nevertheless very light. Contracts for this year were not heavy, but no small part of the tonnage will be carried over.

Steel Prices

On the whole it can be said that the trend in steel prices is toward stiffness. There is certainly no downward trend in general. There are, however, various cross-currents. In bars, shapes and plates several mills are firmer in their price views than a few weeks ago, but there is some aggressive selling with very close prices named, possibly a shade lower than two or three months ago. It is distinctly favorable, however, that the general level on these three products is not materially lower, even in a period of two or three months. In sheets the price situation is somewhat complicated. Nearly all the independent sheet mills have announced a second advance of $5 a ton, following the one that occurred in September, but there is question whether the advance will really be established, and there is room for suspicion that there is a "paper" advance, made chiefly for the purpose of encouraging the placing of orders at the former prices. There is also the complication that while the advance now talked of would raise blue annealed from 2.50c. to 2.75c., there has been selling of late at the old price of 2.25c., ruling before the September advance. The September advances in black sheets to 3c. and in galvanized to 4c. are well held. In wire products 60-day contracts were made just before the Sept. 12 advance, and some small sales are now being made at the advanced prices, but it is understood that some attractive orders are being accepted at the old prices. Tubular goods are quite steady in price, with the usual exception of line pipe.

The pig-iron markets are distinctly dull, whether from consumption failing to increase or from buyers having renewed expectations of lower prices on account of prospective reductions in coke and limestone freight rates. Quotations in the local market are unchanged at $20 for bessemer, $19.25@$20 for basic and $21 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being $1.96.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0.40 – $0.45
Acetone	lb.	$0.12½ – $0.12½	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2.75 – 3.00	3.25 – 3.50
Acetic, 56 per cent	100 lbs.	5.50 – 5.75	6.00 – 6.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		10.50 – 11.00	11.25 – 10.50
Boric, crystals	lb.	.12½ – .13	.13½ – .14
Boric, powder	lb.	.13 – .13½	.14 – .14½
Citric	lb.	—	.45 – .47
Hydrochloric	100 lb.	1.25 – 1.50	1.60 – 1.75
Hydrofluoric, 52 per cent	lb.	.12 – .12½	.12½ – .13
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C.P	lb.	3.25 – 3.50	3.60 – 4.00
Muriatic, 20 deg. (see hydrochloric)		—	—
Nitric, 40 deg	lb.	.06½ – .06½	.06½ – .07
Nitric, 42 deg	lb.	.06½ – .07	.07½ – .07½
Oxalic, crystals	lb.	.15½ – .16	.16½ – .17
Phosphoric, 50 per cent solution	lb.	.13 – .13½	.14 – .18
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	—	1.75 – 1.90
Sulphuric, 60 deg., tank cars	ton	—	11.00 – 12.00
Sulphuric, 60 deg., drums	ton	—	13.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	17.00 – 18.00	—
Sulphuric, 66 deg., drums	ton	21.00 – 22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	21.00 – 22.00	—
Sulphuric, fuming, 20 per cent (oleum) drums	ton	23.00 – 23.50	24.00 – 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P	lb.	—	.75 – .85
Tannic (tech.)	lb.	.45 – .48	.50 – .55
Tartaric, imported crystals	lb.	—	.26 – .27
Tartaric acid, imported, powdered	lb.	—	.27½ – .28½
Tartaric acid, domestic	lb.	—	— .35
Tungstic, per lb. of WO	lb.	—	1.10 – 1.20
Alcohol, Ethyl	gal.	—	4.65 – 4.90
Alcohol, Methyl (see methanol)		—	—
Alcohol, denatured, 188 proof	gal.	—	.35 – .36
Alcohol, denatured, 190 proof	gal.	—	.37 – .38
Alum, ammonia, lump	lb.	.03½ – .03½	.04 – .04½
Alum, potash, lump	lb.	.03½ – .04	.04½ – .04½
Alum, chrome lump	lb.	.10 – .11	.11½ – .12½
Aluminum sulphate, commercial	lb.	.01½ – .02	.02½ – .02½
Aluminum sulphate, iron free	lb.	.02½ – .02½	.03 – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07½	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .32	.33 – .35
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium chloride, granular (white salammoniac)	lb.	.06 – .06½	.06½ – .07
Ammonium chloride, granular (gray salammoniac)	lb.	.06½ – .07	.07½ – .08
Ammonium nitrate	lb.	.07½ – .07½	.07½ – .08½
Amylacetate	gal.	—	3.25 – 3.50
Amylacetate tech	gal.	—	2.50 – 3.00
Arsenic oxide, (wnite arsenic) powdered	lb.	.05½ – .06	.06½ – .06½
Arsenic, sulphide, powdered (red arsenic)	lb.	.11 – .11½	.12 – .13
Barium chloride	ton	47.00 – 48.00	49.00 – 50.00
Barium dioxide (peroxide)	lb.	.20 – .21	.22 – .23
Barium nitrate	lb.	.07½ – .08	.08½ – .09
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04½	.04½ – .05
Bleaching powder (see calc. hypochlorite)		—	—
Blue vitriol (see copper sulphate)		—	—
Borax (see sodium borate)		—	—
Brimstone (see sulphur, roll)		—	—
Bromine	lb.	.27 – .28	.28½ – .30
Calcium acetate	100 lbs.	2.00 – 2.05	—
Calcium carbide	lb.	.04½ – .04½	.05 – .05½
Calcium chloride, fused, lump	ton	23.50 – 24.00	24.50 – 25.50
Calcium chloride, granulated	lb.	.01½ – .02	.02½ – .02½
Calcium hypochloride (bleach'g powder)	100 lb.	2.50 – 2.60	2.70 – 3.25
Calcium peroxide	lb.	—	1.40 – 1.50
Calcium phosphate, tribasic	lb.	—	.15 – .16
Camphor	lb.	—	.76 – .77
Carbon bisulphide	lb.	.06½ – .06½	.07 – .07½
Carbon tetrachloride, drums	lb.	.10½ – .10½	.11 – .12
Carbonyl chloride, (phosgene)	lb.	—	.60 – .75
Caustic potash (see potassium hydroxide)		—	—
Caustic soda (see sodium hydroxide)		—	—
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.08 – .09	.09½ – .10
Chloroform	lb.	—	.40 – .43
Cobalt oxide	lb.	—	2.00 – 2.10
Copperas (see iron sulphate)		—	—
Copper carbonate, green precipitate	lb.	.19 – .19½	.20 – .21
Copper cyanide	lb.	—	.50 – .62
Copper sulphate, crystals	lb.	.05 – .05½	.05½ – .06
Cream of tartar (see potassium bitartrate)		—	—
Epsom salt (see magnesium sulphate)		—	—
Ethyl Acetate Com. 85%	gal.	—	1.00 – 1.10
Ethyl Acetate pure (acetic ether, 98% to 100%)	lb.	—	.40 – .42
Formaldehyde, 40 per cent	lb.	.11½ – .12	.12½ – .13
Fusel oil, ref	gal.	—	3.25 – 3.75
Fusel oil, crude	gal.	—	1.75 – 2.00
Glauber's salt (see sodium sulphate)		—	—
Glycerine, C. P. drums extra	lb.	—	.14 – .15
Iodine, resublimed	lb.	—	3.50 – 3.60
Iron oxide, red	lb.	—	.10 – .20
Iron sulphate (copperas)	ton	18.00 – 19.00	20.00 – 23.00
Lead acetate	lb.	—	.10½ – .12½
Lead arsenate, paste	lb.	.09 – .09½	.10 – .11
Lead nitrate	lb.	—	.15 – .20
Litharge	lb.	.07½ – .08	.08½ – .09
Lithium carbonate	lb.	—	1.30 – 1.40
Magnesium carbonate, technical	lb.	.08 – .08½	.09 – .10
Magnesium sulphate, U. S. P	100 lb.	2.50 – 2.75	—
Magnesium sulphate, technical	100 lb.	—	1.10 – 1.75
Methanol, 95%	gal.	—	.66 – .68
Methanol, 97%	gal.	—	.70 – .72
Nickel Salt, double	lb.	—	.12 – .12½
Nickel salt, single	lb.	—	.14 – .14½
Phosgene (see carbonyl chloride)		—	—
Phosphorus, red	lb.	.40 – .41	.42 – .45
Phosphorus, yellow	lb.	—	.30 – .35
Potassium bichromate	lb.	.10 – .11	.11½ – .11½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ .... – $....	$0.25½–$0.28
Potassium bromide, granular	lb.	..... –	.14 – .20
Potassium carbonate, U. S. P.	lb.	.20 – .21	.22 – .25
Potassium carbonate, 80–85%	lb.	.04½– .04¾	.05 – .06
Potassium chlorate, crystals	lb.	.08 – .08¼	.08½– .12
Potassium cyanide	lb.	..... –	.26 – .28
Potassium hydroxide (caustic p tash)	lb.	.05¾– .06	.06½– .08
Potassium iodide	lb.	..... –	2.60 – 2.75
Potassium nitrate	lb.	.07¾– .07¼	.08 – .09
Potassium permanganate	lb.	.18 – .19	.20 – .22
Potassium prussiate, red	lb.	.28 – .29	.29½– .30
Potassium prussiate, yellow	lb.	.20 – .20½	.21 – .22
Rochelle salts (see sodium potas tartrate)	....	..... –	..... – .....
Salammoniac (see ammonium chloride)	....	..... –	..... – .....
Sal soda (see sodium carbonate)	....	..... –	..... – .....
Salt cake (bulk)	ton	..... –	20.00 –22.00
Silver cyanide	oz.	..... –	1.35 – 1.38
Silver nitrate	oz.	..... –	.46 – .47
Soda ash, light 100	lb.	2.05 – 2.10	2.15 – 2.50
Soda ash, dense 100	lb.	2.35 – 2.40	2.45 – 2.70
Sodium acetate	lb.	.04 – .04½	.04½– .05
Sodium bicarbonate 100	lb.	2.00 – 2.25	2.50 – 2.75
Sodium bichromate	lb.	.07¼– .08	.08½– .08½
Sodium bisulphate (nitre cake)	ton	5.00 – 5.25	5.50 – 6.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½– .05	.05½– .06
Sodium borate (borax)	lb.	.05½– .06	.06½– .07
Sodium carbonate (sal soda) 100	lb.	1.75 – 1.90	2.00 – 2.25
Sodium chlorate	lb.	.07½– .07¾	.08 – .08½
Sodium cyanide	lb.	.25 – .26	.27 – .30
Sodium fluoride	lb.	.10½– .11	.11½– .12
Sodium hydroxide (caustic soda) 100	lb.	4.05 – 4.15	4.20 – 4.75
Sodium hyposulphite	lb.	..... –	.03½– .03¾
Sodium nitrite	lb.	.06½– .07	.07½– .07¾
Sodium peroxide, powdered	lb.	.25 – .26	.27 – .30
Sodium phosphate, dibasic	lb.	.04½– .04¾	.04½– .05¼
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.21 – .24
Sodium prussiate, yellow	lb.	.14½– .14¾	.14½– .15
Sodium silicate, solution (40 deg.) 100	lb.	1.00 – 1.15	1.25 – 1.40
Sodium silicate, solution (60 deg.)	lb.	.02½– .03	.03½– .03¾
Sodium sulphate, crystals (Glauber's salt) 100	lbs.	1.50 – 1.75	2.00 – 2.25
Sodium sulphide, fused, 60–62 per cent (cone.)	lb.	.04½– .04¾	.05 – .06
Sodium sulphite, crystals	lb.	.03¾– .03¾	.03½– .04
Strontium nitrate, powdered	lb.	.12 – .13	.13½– .20
Sulphur chloride, red	lb.	.05 – .05½	.05½– .06½
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour 100	lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone) 100	lb.	..... –	2.00 – 2.75
Tin bichloride, 50 per cent	lb.	.18 – .19	..... – .....
Tin oxide	lb.	..... –	.38 – .40
Zinc carbonate, precipitate	lb.	.16 – .16½	.17 – .17½
Zinc chloride, gran.	lb.	.09¼– .09¾	.10 – .11
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc dust	lb.	.11¼– .11½	.11½– .12½
Zinc oxide, XX	lb.	.07½– .07¾	.08 – .09
Zinc sulphate 100	lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.15 — $1.20
Alpha-naphthol, refined	lb.	1.25 — 1.30
Alpha-naphthylamine	lb.	.27 — .30
Aniline oil, drums extra	lb.	.17½— .20
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.35
Benzidine, base	lb.	.90 — 1.00
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.52 — .55
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)	gal.	.25 — .28
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.50 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech	lb.	.31 — .34
Beta-naphthyla mine, sublimed	lb.	1.75 — 1.85
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .17
Ortho-cresol, in drums (100 lb.)	lb.	.25 — .27
Cresylic acid, 97–99%, straw color, in drums	gal.	.70 — .80
Cresylic acid, 95-97%, dark, in drums	gal.	.65 — .70
Cresylic acid, 50%, first quality, drums	gal.	.45 — 50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.00 — 1.15
Dimethylaniline	lb.	.41 — .50
Dinitrobenzene	lb.	.23 — .27
Dinitroclorbenzene	lb.	.23 — .25
Dinitronaphthalene	lb.	.30 — .35
Dinitrophenol	lb.	.35 — .40
Dinitrotoluene	lb.	.25 — .30
Dip oil, 25%, car lots, in drums	gal.	.30 — .35
Diphenylamine	lb.	.60 — .70
H-acid	lb.	1.10 — 1.20
Meta-phenylenediamine	lb.	1.15 — 1.20
Monochlorbenzene	lb.	.12 — .14
Monoethylaniline	lb.	1.60 — 1.70
Naphthalene crushed, in bbls.	lb.	.06½— .07½
Naphthalene, flake	lb.	.06½— .07½
Naphthalene, balls	lb.	.08 — .09½
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17
Ortho-amidophenol	lb.	3.00 — 3.10
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.40 — 1.45
Para-amidophenol, HCl	lb.	1.70 — 1.80
Para-dichlorbenzene	lb.	.12 — .15
Paranitroaniline	lb.	.77 — .80
Para-nitrotoluene	lb.	.80 — .85
Para-phenylenediamine	lb.	1.70 — 1.75
Para-toluidine	lb.	1.25 — 1.40
Phthalic anhydride	lb.	.40 — .50
Phenol, U. S. P., drums	lb.	.09 — .12
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.50 — 1.60
Resorcinol, pure	lb.	2.00 — 2.25
Salicylic acid, tech., in bbls.	lb.	.18 — .20
Salicylic acid, U. S. P.	lb.	.19 — .22
Salol	lb.	.60 — .70
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 — .16
Sulphanilic acid, crude	lb.	.27 — .30
Tolidine	lb.	1.30 — 1.35
Toluidine, mixed	lb.	.43 — .45
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.28 — .31
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — .....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — .....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.19 —	$0.20
Beeswax, refined, dark	lb.	.24 —	.25
Beeswax, refined, light	lb.	.28 —	.30
Beeswax, white pure	lb.	.36 —	.42
Candelilla wax	lb.	.24 —	.25
Carnauba, No. 1	lb.	.46 —	.47
Carnauba, No. 2, North Country	lb.	.24 —	.24½
Carnauba, No. 3, North Country	lb.	.14½—	.15
Japan	lb.	.21½—	.22½
Montan, crude	lb.	.05 —	.05½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.03½—	.03½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02 —	.....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 —	.03½
Paraffine waxes, refined, 125 m.p.	lb.	.03½—	.03½
Paraffine waxes, refined, 128-130 m.p.	lb.	.03½—	.04¼
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½—	.05
Paraffine waxes, refined, 135-137 m.p.	lb.	.05½—	.06
Stearic acid, single pressed	lb.	.09½—	.....
Stearic acid, double pressed	lb.	.10½—	.....
Stearic acid, triple pressed	lb.	.11 —	.11¼

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.55 —	5.65
Rosin E-I	280 lb.	5.75 —	6.25
Rosin K-N	280 lb.	6.35 —	6.75
Rosin W. G.-W. W.	280 lb.	6.90 —	7.40
Wood rosin, bbl.	280 lb	6.25 —	.....
Spirits of turpentine	gal.	.74 —	.....
Wood turpentine, steam dist	gal.	.72 —	.....
Wood turpentine, dest. dist.	gal.	.71 —	.....
Pine tar pitch, bbl.	200 lb.	..... —	6.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	11.00
Retort tar, bbl.	500 lb.	—	11.00
Rosin oil, first run	gal.	.35 —	.....
Rosin oil, second run	gal.	.37 —	.....
Rosin oil, third run	gal.	.44 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.37
70-72 deg., steel bbls. (85 lb.)	gal.	.35
68-70 deg., steel bbls. (85 lb.)	gal.	.34
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23

Fertilizers

Ammonium sulphate, bulk and d. bags	100 lb.	$2.70 —	3.00
Blood, dried, f.o.b., N. Y.	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Cyanamide, f.o.b. works	unit	4.50	
Fish scrap, dom., dried, f.o.b. works	unit	2.90 —	3.00
Nitrate soda	100 lb.	2.35 —	2.45
Tankage, high grade, f.o.b. Chicago	unit	3.00 —	3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c.	ton	4.50 —	6.50
Tennessee, 78-80 p.c.	ton	8.00 —	9.00
Potassium muriate, 80 p.c.	ton	37.50 —	40.00
Potassium sulphate	unit	1.15 —	1.20

Crude Rubber

Para—Upriver fine	lb.	$0.21 —	.21½
Upriver coarse	lb.	.11½ —	.12
Upriver caucho ball	lb.	.11½ —	.12
Plantation—First latex crepe	lb.	.15½ —	.15½
Ribbed smoked sheets	lb.	.15½ —	.15½
Brown crepe, thin, clean	lb.	.15 —	.....
Amber crepe No. 1	lb.	.17 —	.....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10½ —	$0.10¾
Castor oil, AA, in bbls.	lb.	.11½ —	.12
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.15½ —	.16
Cocoanut oil, Ceylon grade, in bbls.	lb.	.09½ —	.10
Cocoanut oil, Cochin grade, in bbls.	lb.	.10½ —	.11
Corn oil, crude, in bbls.	lb.	.09 —	.09½
Cottonseed oil, crude (f. o. b. mill)	lb.	.07 —	.07¼
Cottonseed oil, summer yellow	lb.	.08½ —	.09
Cottonseed oil, winter yellow	lb.	.09½ —	.09¾

Linseed oil, raw, car lots (domestic)	gal.	.68	—	.69
Linseed oil, raw, tank cars (domestic)	gal.	.63	—	.64
Linseed oil, in 5-bbl lots (domestic)	gal.	.71	—	.72
Olive oil, Denatured	gal.	$1.15	—	*$1.20
Palm, Lagos	lb.	.07	—	.07¼
Palm, Niger	lb.	.06½	—	.06⅝
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08	—	.08½
Peanut oil, refined, in bbls	lb.	.11½	—	.11⅝
Rapeseed oil, refined in bbls	gal.	.90	—	.91
Rapeseed oil, blown, in bbls	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08¼	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07¼	—	....
FISH				
Light pressed menhaden	gal.	$0.40	—	....
Yellow bleached menhaden	gal.	.42	—	....
White bleached menhaden	gal.	.44	—	....
Blown menhaden	gal.	.48	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	20.00	—	24.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri	net ton	7.00	—	....
Blanc fixe, dry	lb.	.04	—	.04½
Blanc fixe, pulp	net ton	45.00	—	55.00
Casein	lb.	.07	—	.10
Chalk, Precipitated, domestic, extra light	lb.	.04½	—	.05
Chalk, Precipitated, domestic, light	lb.	.04	—	.04½
Chalk, Precipitated, domestic, heavy	lb.	.03½	—	.04
Chalk, Precipitated, English, extra light	lb.	.04½	—	.05
Chalk, Precipitated, English, light	lb.	.04½	—	.05
Chalk, Precipitated, English, dense	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00	—	20.00
China clay (kaolin), imported, lump	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla	net ton	18.00	—	....
Fullers earth, imported, powdered	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality	lb.	.06	—	.07
Graphite, Ceylon chip	lb.	.04½	—	.05
Graphite, high grade amorphous crude	lb.	.00½	—	.02½
Kieselguhr, f.o.b. mines, Cal	per ton	40.00	—	....
Kieselguhr, f.o.b. N.Y	per ton	61.00	—	....
Magnesite, calcined	per ton	66.00	—	70.00
Pumice stone, imported	lb.	.03	—	.40
Pumice stone, domestic, lump	lb.	.05	—	.05½
Pumice stone, domestic, ground	lb.	.06	—	.07
Quarts (acid tower) first to head, f.o.b. Baltimore	net ton	....	—	10.00
Quarts (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	....	—	14.00
Quarts (acid tower) rice, f.o.b. Baltimore	net ton	....	—	17.00
Quarts, lump, f.o.b. North Carolina	net ton	5.00	—	7.50
Shellac, orange fine	lb.	.66	—	.68
Shellac, orange superfine	lb.	.70	—	.72
Shellac, A. C. garnet	lb.	.53	—	.55
Shellac, T. N.	lb.	.59	—	.61
Soapstone	ton	2.00	—	15.00
Sodium chloride	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars	ton	7.50	—	11.00
Talc, imported	ton	30.00	—	40.00
Talc, California talcum powder grade	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton		$50.00
Carborundum refractory brick, 9-in. — less than carlot	1,000		1250.00
Carborundum refractory brick, 9-in. — carload lots	1,000		1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton	52–	55
Chrome cement, 40–45% Cr_2O_3	net ton	30–	32
Chrome cement, 40–45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	33–	35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	35–	40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	30–	35
Magnesite brick, 9-in. straight	net ton	65–	70
Magnesite brick, 9-in. arches, wedges and keys	net ton		77
Magnesite brick, soaps and splits	net ton		98
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	40–	42
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	42–	45
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	35–	38

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$225.00
Ferrochrome per lb. of Cr. contained, 6–8% carbon, carlots	lb.	.11	—	....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.11	—	12
Ferromanganese, 76-80% Mn, domestic	gross ton	60.00	—	63.00
Ferromanganese, 76-80% Mn, English & German	gross ton	59.00	—	60.00
Spiegeleisen, 18-22% Mn	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25	—	....
Ferrosilicon, 10-15%	gross ton	38.00	—	40.00
Ferrosilicon, 50%	gross ton	60.00	—	65.00
Ferrosilicon, 75%	gross ton	130.00	—	135.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40	—	.45
Ferrouranium, 35-50% of U, per lb. of U content	lb.	6.00	—	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$8.00	—	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	24.00	—	26.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	24.00	—	26.00
Coke, foundry, f.o.b. ovens	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens	net ton	3.25	—	3.50
Coke, petroleum, refinery, Atlantic seaboard	net ton	12.00	—	13.00
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	15.00	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00	—	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	—	.01⅝
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.20	—	.21
Manganese ore, chemical (MnO_2)	net ton	50.00	—	55.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55	—	.60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00	—	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.11	—	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.15	—	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.75	—	3.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25	—	2.50
Vanadium pentoxide, 99%	lb.	2.00	—	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00	—	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½	—	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.00
Aluminum, 98 to 99 per cent	24.50@25.00
Antimony, wholesale lots, Chinese and Japanese	5.00@5.25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	28.00
Lead, New York, spot	4.70@4.75
Lead, E. St. Louis, spot	4.45@4.50
Zinc, spot, New York	5.05@5.10
Zinc, spot, E. St. Louis	4.675

OTHER METALS

Silver (commercial)	oz.	$0.71½
Cadmium	lb.	1.00–1.25
Bismuth (500 lb. lots)	lb.	1.50@1.55
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	82.00
Iridium	oz.	150.00@170.00
Palladium	oz.	55.00–60.00
Mercury	75 lb.	38.00–39.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.50
Copper bottoms	28.00
Copper rods	19.00@19.75
High brass wire	15.75
High brass rods	13.25
Low brass wire	17.25
Low brass rods	17.25
Brazed brass tubing	25.00
Brazed bronze tubing	27.75
Seamless copper tubing	19.50
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible	9.50@10.00	9.25	9.50
Copper, heavy and wire	9.00@9.25	8.50	8.50
Copper, light and bottoms	7.50@8.00	7.50	7.25
Lead, heavy	3.25@3.50	3.25	3.25
Lead, tea	2.25@2.35	2.25	2.25
Brass, heavy	4.25@4.50	4.50	5.00
Brass, light	3.25@3.50	3.25	3.50
No. 1 yellow brass turnings	4.00@4.25	4.25	4.50
Zinc	2.00@2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. aref or structural shapes 3 in. by ¼ in. and arger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.88	$2.88	$2.88
Soft steel bars	2.78	2.78	2.78
Soft steel bar shapes	2.78	2.78	2.78
Soft steel bands	3.42	3.48	3.48
Plates, ¼ to 1 in. thick	2.88	2.88	2.88

*Add 15c per 100 lb. for truckin to Jersey City and 10s for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

SELMA—The Fresno Tire & Ruber Co., Fresno, Cal., is planning for the erection of a new plant at Selma, estimated to cost about $200,000, including machinery.

MARIA—The Imperial Valley Gypsum & Oil Co., Spreckels Bldg., San Diego, Cal., has acquired property at Maria, Imperial Co., comprising about 170 acres of land, as a site for the erection of a new oil refinery and gypsum manufacturing plant. For raw material supply for the latter works, the company has purchased extensive deposits about 25 miles north of Maria. The initial plants are estimated to cost about $150,000.

MARTINEZ—Fire, Oct. 5, damaged a portion of the local oil refinery of the Associated Oil Co., with loss estimated at about $50,000.

BERKELEY—The Superior Tile & Products Co., 1910 Prince St., has preliminary plans under way for the erection of a new plant, estimated to cost about $15,000.

CARPINTERIA — The Carpinteria Clay Products Co., recently organized with a capital of $150,000, has commenced the operation of a local plant for the manufacture of brick and tile products. At a later date it is planned to expand the works, with department for the production of chinaware and other ceramic products. The company is headed by Lyman T. Gage, B. C. Sutton and L. L. Brentner.

Connecticut

NEW LONDON—The Massachusetts Oil Co., Pequot Ave., will make extensions in its local works, including the erection of a 1-story building, 30 x 75 ft., to cost about $12,000.

Delaware

WILMINGTON—The Christiana Leather Co., headed by James J. O'Neill, president of the Wilmington Leather Co., is arranging for the early opening of its tannery, with initial capacity of about 250 skins per day. The plant will give employment to about 100 men.

Florida

PENSACOLA — The Southern Pine Extracts Co. is planning for the establishment of a new local plant for the manufacture of pine oils, turpentine and kindred products. James W. Ely is head.

JACKSONVILLE—The Tidewater Glass Mfg. Co. is perfecting plans for the erection of its proposed new local plant on waterfront property totaling 325 x 1,500 ft., recently acquired. The works will consist of three complete operating units, each 2-story, 60 x 300 ft., and estimated to cost about $150,000, including machinery. The plant will specialize in the manufacture of glass bottles, jars, etc. Erection bids will soon be asked. B. R. Kessler is secretary.

Illinois

CHICAGO—The Waterway Paper Products Co., Kedzie Ave. and 32d St., has commenced the erection of its proposed new plant at location noted, consisting of a main 1-story building, 80 x 180 ft., with power plant, 33 x 60 ft., estimated to cost about $200,000, with machinery. Frank D. Chase, Inc., 645 Michigan Ave., is architect and engineer.

Indiana

VINCENNES—Fire, Oct. 11, destroyed a portion of the flour-milling plant of the Atlas Mills, with loss estimated at close to $200,000, with machinery.

Maryland

FROSTBURG — The Big Savage Brick Co. has commenced the erection of a new drying department at its plant and will soon inaugurate operations for other extensions, estimated to cost about $85,000. D. A. Benson is manager.

BALTIMORE — The Spanish-American Cork Products Co., Westport, near Baltimore, is planning for the immediate rebuilding of the portion of its local plant on Fish House Road, recently destroyed by fire with loss of about $75,000. O. J. Harms is president.

Massachusetts

SOMERVILLE — Masury, Young & Co., 196 Milk St., Boston, Mass., manufacturer of oil products, etc., will equip a portion of its new 3-story building now being erected on Rollins St., Somerville, 35 x 75 ft., as an oil-testing works.

CHELSEA—The United Indigo & Chemical Co., 960 Broadway, will commence the immediate rebuilding of the portion of its plant recently destroyed by fire, with cost estimated at $21,000. John Cowen is superintendent.

Michigan

DETROIT — The Detroit Sand Lime Brick Co., 507 Vinton Bldg., will soon take bids for the erection of its proposed new plant. Plans are nearing completion.

New Hampshire

HINSDALE—Fire, Oct. 5, destroyed a portion of the paper mill of the G. A. Robertson Co., with loss estimated at close to $100,000, including machinery.

New Jersey

JERSEY CITY—The Apex Color Works, Inc., 61 Cornielson Ave., has completed plans and is taking bids for the erection of a new 1-story plant, 50 x 100 ft., on Van Winkle Ave., estimated to cost about $22,000. Edward Patterson, 76 Montgomery St., is architect.

WOODSTOWN—The South Jersey Farmers' Exchange is considering tentative plans for the erection of a new local plant for the manufacture of fertilizer products.

BAYONNE — The Standard Oil Co. of New Jersey, 26 Broadway, New York, is arranging an appropriation of $2,000,000, for extensions and improvements in its three refineries in this section, comprising the Constable Hook works at Bayonne; the Eagle Works at Jersey City, and the Bayway plant at Elizabeth. Walter C. Teagle is president.

New York

LONG ISLAND CITY—A. L. Reade & Co., 141 West 36th St., New York, manufacturer of celluloid specialties and novelties, has leased the 2-story brick building now being erected on Ely Ave., near the Bridge Plaza, Long Island City, for a new plant.

BUFFALO—The Buffalo Specialty Co., 375 Ellicott St., is said to be planning for the rebuilding of its plant at Bridgeburg, Ont., destroyed by fire, Oct. 13, with loss estimated at about $50,000.

BUFFALO—The Niagara Gas Corp., 186 Main St., has preliminary plans under way for the erection of a new gas filtration and purifying plant at South Buffalo, in the vicinity of the works of the Donner Union Coke Co., estimated to cost about $350,000. The company recently took over the artificial gas plant of William J. Judge, and has increased its capital to $4,000,000.

Pennsylvania

POTTSTOWN—The Hydro United Tire Co., manufacturer of automobile tires, has awarded a contract to Graham & Wells, 3649 Filbert St., Philadelphia, Pa., for the erection of a 2-story plant addition, 134 x 170 ft.

EASTON—The Forbes Aluminum Products Co., Steele Bldg., has awarded a contract to the R. T. & C. D. Stewart Construction Co., 26 Center Sq., for the erection of its new plant in the South Side section, to consist of a number of buildings of various size, estimated to cost about $150,000. Later proposed extensions will bring the ultimate investment to close to $500,000. The company was incorporated recently under Delaware laws with capital of $4,500,000. Ewing M. Forbes is president. A. D. Childsey, Jr., 341 Northampton St., Easton, is architect and engineer.

BETHLEHEM — The Travelers' Rubber Co. will install new machinery at its plant for increased production, estimated to cost about $30,000.

NEW BRIGHTON—The Townsend Co., manufacturer of iron and wire products, has construction under way on a new wire mill on Fallston Ave., occupying a large portion of a 3-story building, 124 x 128 ft.

South Carolina

COLUMBIA — The Halo Co., recently organized with a capital of $400,000 to manufacture extracts, has plans under way for the erection of a new local plant, 50 x 140 ft. Bids will be asked in about 60 days. E. M. Lowman is secretary.

Tennessee

MEMPHIS — The Memphis Cotton Seed Products Co., recently organized, has acquired a local site for the erection of a new mill. Perliminary plans are under way. A. G. Roberts is president.

MEMPHIS — The Stryker Kot-N-Wood Products Co., has acquired local property as a site for its proposed new mill, 60 x 200 ft., for the manufacture of plasterboard products from cotton stalks. The machinery installation will include hydraulic presses, digesters, shredders, mixers, etc. Other plant unit will be constructed at a later date. George B. Stryker is president.

KNOXVILLE—The Knoxville Pure Paint & Varnish Co., recently formed with a capital of $150,000, has awarded a contract to Worsham Bros., Knoxville, for the erection of a 2-story and basement plant, 50 x 125 ft., for the manufacture of paints, oils, varnishes, etc., estimated to cost about $32,000. J. R. Lee is president and J. C. Trewitt, vice-president.

Texas

DALLAS—The Dallas Oil Refinery Co., 3131 Oak Lane, has preliminary plans under way for the erection of a new oil-refining plant on local site.

SAN ANTONIO — The Grayburg Pipe Line Co., Grayburg Bldg., has awarded a contract to J. S. Young, Somerset, Tex., for the construction of a new oil works, estimated to cost about $40,000 and of which the machinery installation will represent about $25,000.

DALLAS — In connection with the remodeling of the plant of the Eastland Oil & Refining Co., recently acquired, the Trinity Oil Corp. has tentative plans under way for the erection of a new lubricating oil manufacturing plant on an adjoining site. Harry Pennington, Oklahoma City, Okla., is president; J. W. Rieker, Dallas, is manager.

DALLAS — The Fleischmann Yeast Co. has arranged for the erection of a new 2-story building, to be occupied under lease, 50 x 115 ft., estimated to cost about $30,000. It will be equipped for the manufacture of yeast products. Headquarters of the company are at 701 Washington St., New York, N. Y.

Virginia

PORTSMOUTH—The Chesapeake Mfg. & Creosoting Co., Money Point, near Portsmouth, is reported to be planning for the rebuilding of the portion of its plant, recently destroyed by fire with loss estimated in excess of $200,000.

West Virginia

HUNTINGTON — The Camp Glass Co., Twenty-fifth St., is planning for extensions and improvements in its plant to cost about $30,000. The company is operated by the Interstate Glass Co., Bradford, Pa. Daniel Camp is manager.

STAR CITY — The Star Glass Co. has awarded a contract to the Pittsburgh Bridge & Iron Works, Farmers' Bank Bldg., Pittsburgh, for the erection of a new plant to total about 60,000 sq.ft. of floor space. The structure will be equipped for the manufacture of illuminating glassware products.

New Companies

THE RUSH PORCELAIN CO., Room 1922, 24 Archer Ave., Chicago, Ill., has been incorporated with a capital of $40,000, to manufacture porcelain products and kindred specialties. The incorporators are Charles G. Rush, H. Jones and L. L. Cowan.

THE REGAL MFG. CO., Kansas City, Mo., has been incorporated under Delaware laws with capital of $200,000, to manufacture chemicals, insect powders and affiliated specialties. The incorporators are Ray M. and H. L. Dunnett, and Frank D. Auwarter.

Kansas City. The company is represented by the Corporation Service Co., Wilmington, Del.

GEORGE H. CLARK & Co., INC., Worcester, Mass., has been incorporated with a capital of $32,000, to manufacture paints, oils, etc. George A. Clark is president; and Harry A. Clark, 25 West St., treasurer.

THE INSTANT CHEMICAL MFG. CO., New York, N. Y., has been incorporated with a capital of $250,000, to manufacture chemicals and affiliated products. The incorporators are F. M. Dunn, J. L. Nichols, and Guernsey Price, 1 Liberty St.

THE GEM FOUNDRY CO., Muskegon, Mich., has been incorporated with a capital of $10,000, to manufacture brass, aluminum and other metal castings. The incorporators are Harry J. Pangburn, Samuel Feltman and Jacob A. Poupstra, Muskegon.

THE HOWARD FINISHING CO., Meriden, Conn., has been incorporated with a capital of $50,000, to manufacture glassware, porcelain products and kindred specialties. The incorporators are J. L. Howard, Meriden; W. J. Howard, Hartford, Conn.; and J. J. Howard, New Haven, Conn.

THE JUST SOAP MFG. CO., INC., Kearny, N. J., has been incorporated with a capital of $25,000, to manufacture soaps, washing powders, etc. The incorporators Jacob B. Cohen, William M. Grant, and Lovett A. Grant, Lincoln Highway, Kearny.

THE UNITY UTILITIES CORP., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture rubber products. The incorporators are W. B. Sorrelle, H. A. Jacobson and L. J. Annen. The company is represented by H. P. Freese, 27 William St.

THE ILLINOIS-WYOMING OIL CO., 2135 West 72d St., Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture oil products. The incorporators are John F. Stoner and Frank A. Foltz.

THE PROVIDENCE BRASS REFINISHING CO., 47 Mill St., Providence, R. I., has filed notice of organization to manufacture brass, bronze and kindred metal products. William Carroll, 175 Hoyt Ave., Rumford, R. I., heads the company.

THE FEDERAL CARBONIC GAS CO., Jersey City, N. J., has been incorporated with a capital of $500,000, to manufacture carbonic gas and other commercial gas products. The incorporators are Frank E. Taylor, Thomas J. Burke and R. Emmett Sullivan, 57 Randolph Ave., Jersey City.

THE WALKER LUBRICATING OIL & REFINING CORP., New York, N. Y., has been incorporated under Delaware laws with capital of $2,000,000, to manufacture refined oil products. The incorporators are T. B. and W. D. Walker, and John J. Ford, New York. The company is represented by the Delaware Registration Trust Co., 900 Market St., Wilmington, Del.

THE FORT MCCOY TURPENTINE CO., Fort McCoy, Fla., has been incorporated with a capital of $40,000, to manufacture turpentine and kindred products. W. J. Wilson is president, and J. H. Burroughs, secretary and treasurer, both of Fort McCoy.

THE AURORA LEATHER CO., 6030 South State St., Chicago, Ill., has been incorporated with a capital of $15,000, to manufacture leather products. The incorporators are Abraham Sohn and N. S. Wolf.

THE WELNESS PAINT CO., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture paints, varnish, etc. The incorporators are P. J. Welch, B. W. and T. F. Guinness. The company is represented by D. F. Griffin, 44 Court St., Brooklyn, N. Y.

THE DOSCH CHEMICAL CO., Wilmington, Del., has been incorporated under Delaware laws with capital of $2,500,000, to manufacture chemical products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE IOTLA CLAY & MICA CO., Iotla, N. C., has been incorporated with a capital of $50,000, to manufacture clay products, mica goods and kindred specialties. The incorporators are Herman A. Gudger, Asheville, N. C.; A. W. Mangum, Chapel Hill, N. C.; and Francis A. Gudger, 469 Fifth Ave., New York, N. Y.

THE GARY PAINT CO., Gary, Ind., has been incorporated with a capital of $10,000, to manufacture paint, varnish, oils, etc. The incorporators are Edward Jacob, C. W. Stilwell and W. A. Elliott, Gary.

THE TANLAC CO., Dayton, O., has been incorporated under Delaware laws with capital of $50,000, to manufacture chemicals and chemical byproducts, drug specialties, etc. The incorporators are L. N. Conrad, J. B. Coolidge and J. J. Gibson, all of Dayton. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE ANCHORS CHEMICAL & DYE WORKS, East Orange, N. J., has filed notice of organization to manufacture chemicals, dyes and affiliated products. The company is represented by Elwood B. Hendricks, 645 Springdale Ave., East Orange.

THE CUMBERLAND COUNTY REFINERY, INC., Burkesville, Ky., has been incorporated with a capital of $10,000, to manufacture refined oil products. The incorporators are Ernest J. Schabelitz, Burkesville; and Robert H. Wise, Waynesboro, Pa.

THE COLUMBIA CHINA CORP., Porter, Ind., has been incorporated with a capital of $500,000, to manufacture chinaware and other ceramic products. The incorporators are J. R. Mendelson, E. T. Morris and L. I. Sutterman, all of Porter.

THE RED STAR LABORATORIES CO., 3256 Franklin Blvd., Chicago, Ill., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are R. A. Murphy, William R. Swissler and G. W. Andrews.

THE LAWRENCE OIL CO., INC., Norwood, Mass., has been incorporated with a capital of $350,000, to manufacture oil products. Herbert Brady is president, and Ernest H. Grant, 83 Vernon St., Norwood, treasurer.

THE PENN RUBBER BALL CORP., Philadelphia, Pa., has been incorporated with a capital of $5,000,000 under Delaware laws, to manufacture rubber products of various kinds. The company is represented by Frank R. Hansell, Land Title Bldg.

THE FISK OIL CO., Schenectady, N. Y., has been incorporated with a capital of $200,000, to manufacture oil products. The incorporators are M. G. and J. F. Hocker, and H. A. Bradshaw. The company is represented by D. B. Sammon, attorney, Schenectady.

THE HUDSON COUNTY LEATHER & SUPPLIES CO., West Hoboken, N. J., has been incorporated with a capital of $50,000, to manufacture leather chemicals and kindred supplies. The incorporators are P. Coniglio and Frank Valvano, 118 Summit Ave., West Hoboken.

THE KEYSTONE REFRACTORIES CO., Minneapolis, Minn., has been incorporated with a capital of $600,000 under Delaware laws, to manufacture firebrick and other refractory products. The incorporators are H. B. Finch, W. K. Nash and C. R. Wilson, Minneapolis. The company is represented by the Delaware Registration Trust Co., 900 Market St., Wilmington, Del.

THE UNITED STATES AUTO PAINT CO., 20 Warrington St., Providence, R. I., has filed notice of organization to manufacture paints, etc. R. Gighotti heads the company.

THE EDWARDS PETROLEUM CO., Los Angeles, Cal., has been incorporated with a capital of $250,000, to manufacture petroleum products. The incorporators are H. L. Edwards, C. H. Webb and R. M. Galbreth, 607 Citizens' National Bank Bldg., Los Angeles.

THE ATLANTIC EXTRACT CO., Boston, Mass., has been incorporated with a capital of $10,000, to manufacture extracts, compounds, etc. Martin M. Leibell is president, and Nathan Rubin, Chelsea, Mass., treasurer.

THE CEMENT TILE & PRODUCTS CO., Wilmington, Del., has been incorporated under state laws with a capital of $100,000, to manufacture tile and affiliated products. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE T. C. OIL CO., Montgomery, Ala., has been incorporated with a capital of $200,000, to manufacture petroleum products. The incorporators are T. C. Hadley, Montgomery; R. A. Cooper & W. A. McSwain, both of Columbia, S. C.

THE JURICH CO., New York, N. Y., has been incorporated with a capital of $15,000, to manufacture paints, varnishes, etc. The incorporators are L. and T. O. Jurich, and C. Hattlendorf. The company is represented by Charles Novello, 320 Broadway.

THE UNITED ZINC CO., 33 West Illinois St., Chicago, Ill., has been organized to manufacture zinc products. The company is headed by Edward F. Mestling and Willis H. Huston.

THE PARDUE OIL CORP., Wilmington, Del., has been incorporated with a capital of $5,000,000 under Delaware laws, to manufacture petroleum products. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE HARBOR REFINING CO., Long Beach, Cal., has been incorporated with a capital of $1,000,000, to manufacture refined oil products. The incorporators are J. W. Tucker, J. S. Harper, W. A. Miller, Jr., and D. L. Akeley, all of Long Beach.

Capital Increases, Etc.

THE ANCHOR LEATHER CO., 1001 West Division St., Chicago, Ill., has filed notice of increase in capital from $50,000 to $300,000.

THE ATLAS CRUCIBLE STEEL CO., Dunkirk, N. Y., is arranging for a bond issue of $4,000,000, and of which $2,000,000 will comprise the initial distribution, to be sold at an early date.

THE CREPE-KRAFT CO., Newark, N. J., manufacturer of paper products, has filed notice of change of name to the Krepkraft Co. A new plant is now being established in a portion of the former works of the Universal Caster & Foundry Co., Jackson Ave.

THE REFINING & ASSAYING CORP., 40 West Broadway, New York, N. Y., has filed notice of dissolution under state laws.

THE CRYSTAL CHEMICAL CO., organized under New York laws to manufacture chemicals, has filed notice of organization to operate in New Jersey. Charles Kanter, 747 Broad St., Newark, N. J., is representative.

THE PHILLIPS PETROLEUM CO., 115 Broadway, New York, N. Y., operating oil refineries, has arranged for a bond issue of $3,500,000.

THE ELECTRIC ALLOY STEEL CO., Youngstown, O., is arranging for a preferred stock issue to total $750,000.

THE BLUE RIDGE PAINT & COLOR CO., Allentown, Pa., has been adjudged an involuntary bankrupt. John G. Diefenderfer is referee.

Coming Meetings and Events

ACADEMY OF POLITICAL SCIENCE will hold its forty-first annual meeting at the Hotel Astor, New York City, Nov. 4 and 5.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7. More than 100 manufacturers will exhibit their latest gas-burning appliances.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

INDUSTRIAL COST ASSOCIATION will hold its second national conference at Pittsburgh, Pa., Nov. 2-4, with headquarters at the William Penn Hotel.

INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA will hold its anual convention at the Waldorf-Astoria, New York, Nov. 1-5.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society regular meeting.